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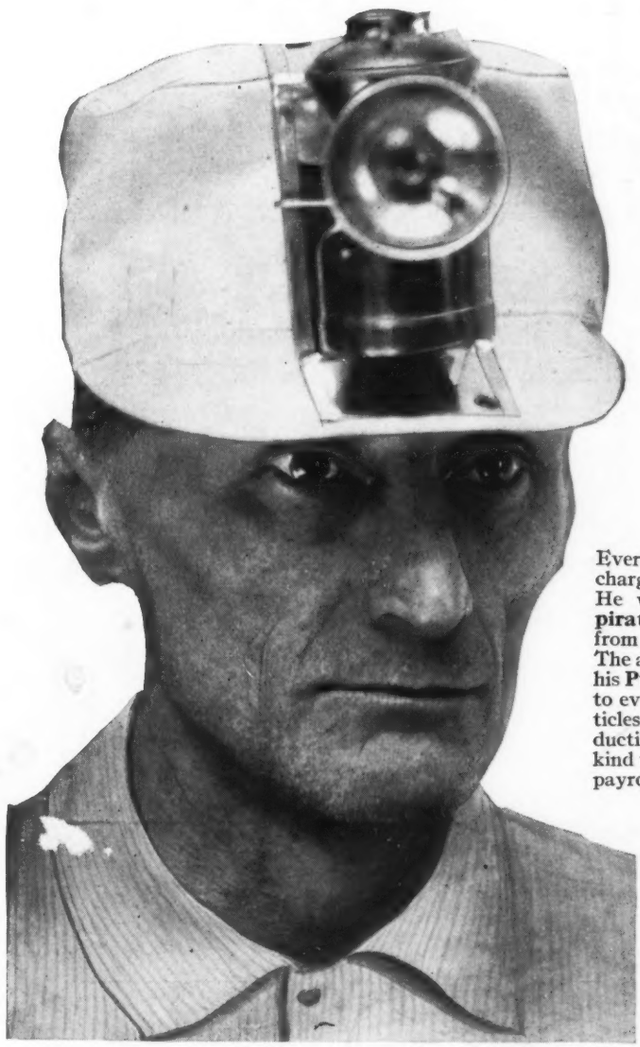

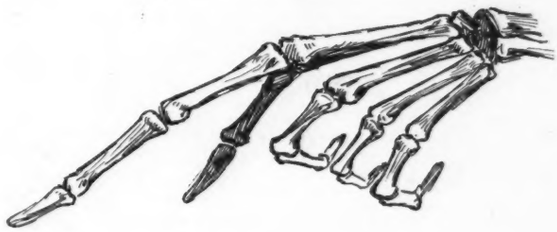

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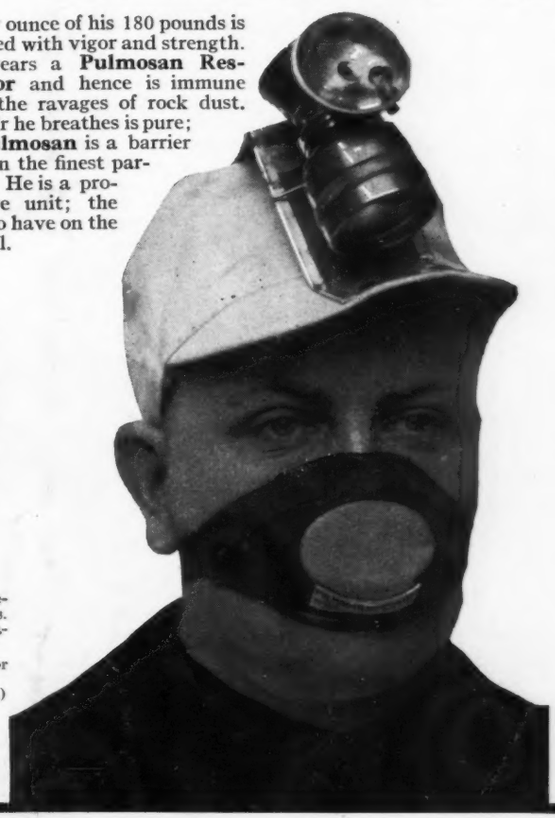

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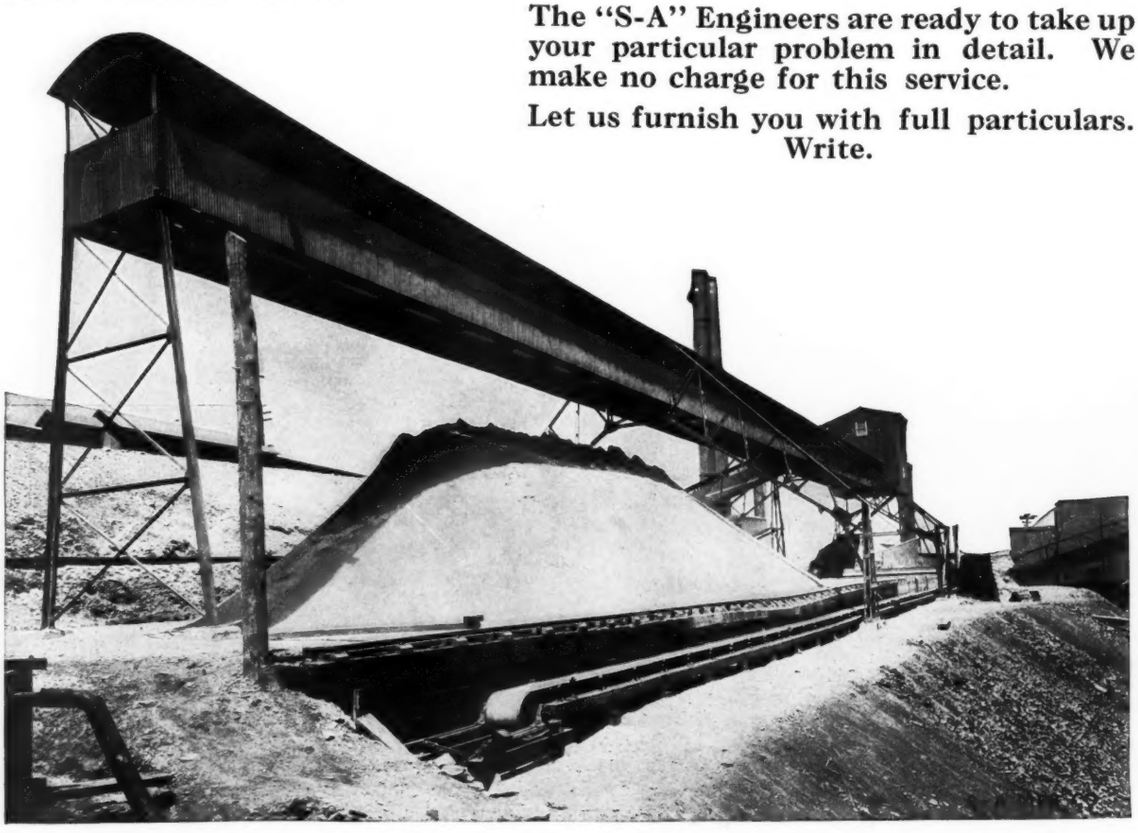

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Mining Journal

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Mining Industry of Brazil

By Benjamin Leroy Miller* and Joseph T. Singewald, Jr.†

SYNOPSIS—Mineral resources of Brazil are varied and extensive, but mining industry has not flourished. It is principally represented by two gold mines, five manganese mines and monazite-sand shipments. Minor outputs of diamonds, semi-precious gem stones, copper and coal. Mining development insignificant, though Brazil exceeds in area the United States.

In many respects Brazil is the least known of any of the major countries of South America, and accurate information regarding it is difficult to obtain. Even the residents of the country seem to be hopelessly ignorant of all sections other than their own immediate one. Before leaving the United States we were unable to secure much exact information, but trusted that this dearth would be readily supplied on reaching Rio de Janeiro, only to find that there it required much time and effort to get even general facts. One must search long in Rio de Janeiro to find a person who can tell him anything definite about the distant states of the country or even the near-by states. In Brazil one soon learns to appreciate the importance of railroads and newspapers in the dissemination of news, and while Brazil was very active in railroad building before the outbreak of the European War, yet the gaps in the railroad system are so great that one region knows little of what another one is doing.

When one reads the scattered literature or examines the mineral specimens in the various Brazilian museums, one is apt to get the idea that all sections of Brazil are rich in their economic mineral resources. Gold is said to occur in every one of the 21 states, while most of them report the presence of numerous other products such as iron, copper, manganese, lead, zinc, antimony, platinum, silver, mercury, monazite; precious stones, including the diamonds, topaz, quartz, amethyst, agate, tourmaline, sapphire, ruby, beryl, emerald and aquamarine; coal, sulphur, graphite, mica, talc, great varieties of clays and

OURO PRETO, FORMER CAPITAL AND MINING CENTER IN MINAS GERAES, THE LEADING MINING STATE OF BRAZIL

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building stones. In most cases the only information to be obtained is that specimens of the particular minerals have been brought from these regions, and no one knows the character of the deposits. With few exceptions the localities yielding the specimens are so remote from transportation lines as to preclude the possibility of their development at present.

Except in a few states the mineral resources of Brazil are entirely undeveloped and their possibilities unknown. While unquestionably the greatest wealth of the country in the future will be derived from agriculture because of every section being suitable for cultivation, grazing or forestry, there is little doubt that the mining industry also is in its infancy. The country needs an increased immigration, which will probably now be slow in coming on account of the European decimation; and until the population and wealth of Brazil materially increase, the greater portion of the agricultural and mineral resources

OUTLINE MAP OF BRAZILIAN STATES

must remain undeveloped, the reserves for future generations.

The mining industry of Brazil has stagnated, while the agricultural and manufacturing industries have rapidly increased in wealth and importance. Many causes have contributed to this state of affairs. The mining laws have for years been in an unsatisfactory condition, and lawyers say that they are in a hopeless jumble. Some states have passed special laws pertaining to mines, but more systematic revision is needed. The Federal law gives all minerals to the owners of the land, and the landholders have been in all too many cases inclined to demand exorbitant prices for the minerals present, and unable or disinclined to operate them themselves. Even when one wishes to buy land, it is a difficult matter to obtain title, as many immense estates have passed undivided through the hands of several generations. Brazilian families are large—10 to 15 children not at all uncommon, and in many cases more than 20 in one family—so one can see the large numbers of owners of an estate undivided for even three generations. In one case we were told of the sale of a mineral property where examination showed it to be held in common by over 700 persons whose titles were good. Under the present conditions the prospector has not had so good an opportunity as in the United States or Canada, and the type of man responsible for the initial stages of mining in North America is practically nonexistent in Brazil. Where surficial decomposition of the rocks is deep and vegetation is dense, prospecting is both difficult and expensive. Systematic prospecting must ever be more profitable in Brazil than desultory one-man exploring parties, and for such work capital, thus far lacking, is absolutely necessary.

In comparison with the past the decadence of mining is probably due mainly to the change in the labor situation. When slavery existed, low-grade gold and diamond mines that are now idle could be worked with profit. As the soil is very fertile, a slave who was allotted a small plot of land would with one or two days' labor each week produce enough for the support of himself and family, and during the remainder of the time he would wash gold and diamonds for his owner. All this was changed with the abolition of slavery, and the shortage of the labor supply and the exhaustion of the precious minerals that could be obtained by small outlay of capital have caused a great decrease in the mining industry.

Most Important Mines Held by Foreigners

The most important mines now in operation are owned by foreign capital, and as few rich Brazilians care to engage in mining, more money from the countries of Europe or North America must be forthcoming before mining in Brazil attains the importance that the varied character of its mineral resources would seem to warrant.

At present practically all the mining in Brazil is confined to four states: The state of Bahia produces some manganese, monazite, gold and diamonds; Goyaz has some working gold and diamond mines; Espirito Santo produces most of the monazite exported from the country; while the state of Minas Geraes, which has from the beginning been the principal mining region, has extensive gold, manganese and diamond workings and contains enormous iron-ore deposits unequaled in any other part of the world. By many persons Goyaz is regarded as the most promising mining state, but its lack of railroads and the almost complete absence of any development work prevent one from forming any definite conclusions regarding its possibilities, and the interest of the mining industry continues to be centered in Minas Geraes. During an extended trip through most of the important mining districts of South and Central America during the past year, we were given an opportunity to visit the various mines of Minas Geraes and to collect information such as they had been unable to obtain before.

The state of Minas Geraes lies due north of Rio de Janeiro and, next to São Paulo, is the richest state in the republic. Although it does not border on the ocean, it was nevertheless one of the first states to be settled, because of the valuable minerals that were early found there. At present it contributes the greater supply of the minerals mined, yet it does not owe its wealth entirely to its mineral resources. Much coffee is grown on the cleared ground, even where the hills are very steep, and the cattle and dairy industries are well developed.

Minas Geraes, although within the tropics, has a pleasant climate, as most of the state lies a few thousand feet above sea level. Many residents of Rio de Janeiro spend

the summer months of January, February and March in Bello Horizonte or other cities of Minas. The country is extremely hilly, and the hills seem scattered everywhere without any order or system. Crooked streams wind their way between the hills, which are in the main steep, especially near the streams.

The country was probably at one time covered with dense forests, but large areas have been cleared, although some regions where the trees have been removed are now covered with thickets of brush so dense that one can scarcely push his way through. Along the streams the forests with the tangles of bamboo and climbing plants form such a barrier that the tapirs and monkeys are the only animals of any size that can pass through them. We experienced considerable difficulty in getting our mules through the thickets where there were no beaten trails constantly in use. So rapidly does the vegetation grow that the paths can be kept open only by the frequent use of the machete.

The mining state of Minas Geraes owes its name to the varied mineral products that were early found there by the Paulist Fathers, who pushed their way inland from the coast settlements. The name means "general mines" or "all kinds of mines."

It is said that the first specimens of gold that the priests obtained from the region were brought to them as early as 1540, but they did not visit the region and find the precious metal themselves until 1694. The Portuguese in Brazil were as eager for gold as were the Spanish on the West Coast, and the search for the yellow metal was extended far and wide and their efforts were rewarded with great success.

In 1721 the first diamonds were discovered in Minas Geraes, near the present town of Diamantina. The story of the discovery is that a priest who had previously seen rough diamonds in India recognized the stones in the stream pebbles that were being worked for gold. Without exciting suspicion he obtained possession of a great many, some of which had been collected by the gold miners on account of their brilliancy, and then journeyed quickly to Rio de Janeiro, whence he sailed for Portugal with his treasures. Just as he was about to sail, he announced that diamonds were being found in the gold field of Minas Geraes. Naturally there was a "rush" to the regions, and the Portuguese government quickly seized all the mines and had them worked for the Crown. While the government profited immensely from the diamond mines for many years, the supply was not exhausted, and the district continues to yield a considerable quantity annually. Statistics of production are of little value, as many are found and never reported, because of the tax which the government imposes upon the stones found.

The iron ores were perhaps the next mineral deposits to attract attention, and small forges were erected in several places throughout the region to supply the gold and diamond workers with the small amount of iron required. But the total amount of iron made from the Brazilian iron ore is inconsiderable, and these extensive deposits remain practically untouched.

The manganese ores of Brazil were developed much later, as they are all exported and no use could be made of these materials until the Central Railroad of Brazil had been extended near the deposits. However, at present the value of the output of manganese ore ranks next to that of gold.

Poorly Managed Government Railroads

The railroads of Brazil have been of the greatest importance to Minas Geraes and yet in their equipment and management leave much to be desired. The one described is a government-owned line, and many of its defects are not seen in the railroads owned and operated by private capital. Leaving Rio de Janeiro at 7 p.m. by the Estrado do Ferro do Brazil, the next morning the mining region of Minas Geraes is reached. To one not acquainted with Brazilian railroads or especially with the government railroads of Brazil, the night ride from Rio is one long to be remembered. The sleeping cars are light and the roadbed so rough and the line, which follows crooked streams, has so many curves that one is continually thrown from side to side of his berth. To lie on one side it is necessary to have arms extended as sort of buttresses. The cars, which are old, have been so shaken apart that in going through tunnels the smoke enters through numerous cracks in such volume as to almost suffocate one, while during the dry season the dust comes into the cars in clouds.

Since the European War caused the price of coal to advance to such a point that its use had to be curtailed, many of the railroads have been using wood in their locomotives. On a dark night the sparks flying from the engine's smoke-stack suggest Fourth of July pinwheels, and it is a common occurrence to have the wooden cars catch fire, while the person who rides far on these trains without having holes burned in his clothes may consider himself lucky.

TYPICAL VIEWS OF MINAS GERAES MINING DISTRICTS—OUTCROPPING LEDGES OF HIGH-GRADE IRON ORE

The standard-gage line extends to Miguel Burnier, 287 mi. from Rio, beyond which the track is narrow gage. The railroad has been built to Pirapora on the São Francisco River, a distance of about 600 mi. Branch lines run to Diamantina, Bello Horizonte, Marianna, Santa Barbara and other points.

While new railroads are projected and will undoubtedly be built as soon as financial conditions are improved, it will be some time before the mining industry will be changed materially. The diamond operations can continue practically as well without railroads as with them, for it has been demonstrated that elaborate equipment is not adapted to the recovery of the precious gems in Brazil. An English company that invested $1,200,000 in a property near Diamantina, which was equipped with steam shovels, etc., failed to make expenses, although the natives working with the shovel and batea are able to make a living. The railroad reached the diamond region less than two years ago, and the industry has shown no improvement.

In the gold region increased railroad facilities will not at once stimulate the mining industry, as the two big gold mines of Brazil are now reached by railroads and the dredging operations are still of questionable value, while the desultory gold washings along the smaller streams could not be aided by better means of transportation.

In spite of poor railroads and high freight rates, the manganese mines of Minas Geraes have done well. The occurrence of other manganese-ore deposits is known, and their geologic character leads one to believe that they may prove to be of equal value to those already in operation. No doubt, as new railroad lines are constructed the manganese industry will be improved.

No Brazilian Coke Available for Smelting Iron Ores

The iron industry is in greatest need of new and better railroads. While the country has hundreds of millions of tons of high-grade iron ore, nevertheless about 500,000 tons of iron is said to be imported annually. The absence of coking coal is the principal handicap in the development of local iron manufacture, and it is generally recognized that Brazil's iron ores must be marketed in foreign countries. The Central R.R. passes through the iron region and branches could be built from it to the most important deposits, but the present line is poorly suited for iron-ore shipment and entirely incapable of handling large amounts. A railroad that is being built from the port of Victoria is not much better, and before the deposits can be extensively worked there must be a line especially constructed for iron-ore shipment, which will involve a large expenditure.

As one goes through the iron region and observes the enormous deposits of almost pure hematite ore, one cannot fail to regret their present inaccessibility. While these deposits have long been known, it was not until Dr. Orville A. Derby called attention to them in 1910, in the report on the "Iron-Ore Resources of the World," prepared for the International Geological Congress held in Stockholm, that foreign interests were attracted to them. American, English and German companies shortly entered the field, and the possession of these valuable deposits has now largely passed into the hands of foreigners, who are at present "sitting tight" and waiting.

In spite of the descriptions that have been published of the Minas Geraes iron-ore deposits, it is doubtful whether anyone who has not seen them can adequately appreciate their extent. A noted iron man of the United States has said that had one of his assistants returned from Minas Geraes with an accurate description of what occurs there, he would have sent him back with the admonition to tell the truth on his next return. In fact, a man who truthfully describes the Brazilian iron-ore deposits is apt to lose any reputation for veracity that he might previously have had. When one sees whole hills of iron ore that would average 65% to 68% Fe, square miles of territory covered with brecciated ore (*canga*) to the extent of 5 to 50 ft., the whole averaging between 50% and 60% Fe, and in places, masses containing 25,000,000 to 50,000,000 tons of 68% Fe ore, he cannot fail to be surprised. It seems that within a radius of 30 to 40 mi. there are a few billion tons of 60% Fe ore and no one knows how much 50% Fe material.

In a few places in the district the loose specular-hematite ores are being worked and iron is made in small forges. The loose ore, consisting of extremely fine bright flakes, is put into a small furnace mixed with charcoal. At intervals more ore and charcoal are added until finally a ball of iron and slag is formed. This is then pounded by a trip hammer run by a waterwheel until the slag is largely removed. There are said to be a number of forges of this kind throughout the iron regions, but thus far the attempts to smelt the iron ores in blast furnaces have not met with much success, even though the Brazilian government has probably offered greater inducements than any other government has ever done to encourage this industry.

The total value of the annual mineral production of Brazil is about $5,000,000. Roughly one-half of this represents the gold output, one-third the manganese, one-tenth the monazite, and the remainder, about $300,000, is divided among the outputs of diamonds, copper and coal plus small amounts of numerous minor products. For a country that exceeds in size the entire United States, excluding Alaska, such figures indicate either the lack of many valuable mineral deposits or else their nondevelopment. The latter cause is thought to be the principal reason for this state of affairs.

Mineral Output of Italy in 1914

According to official reports in *Revista del Servizio Minerario nel* 1914, the principal items of mineral production in Italy in 1914 were as follows, arranged in order of descending value: Sulphur, crude, 2,371,705 metric tons; iron ore, 706,246; zinc ore, 145,914; silver-lead ore, 43,538; iron pyrites, 335,531; lignite, 778,308; mercury ore, 119,223; copper ore, 86,953; petroleum, 5,542; boric acid, 2,537; salt, 18,396; rock salt, 41,715; graphite, 8,567 metric tons; natural gas, 5,920,000 cu.m.; mineral waters, 26,850 metric tons; gold ore, 206; alum, 3,700; manganese ore, 1,649; bauxite, 3,906; antimony ore, 555; bituminous coal, 1,440; bituminous schist, 1,590; tin ore, 36 metric tons.

The principal metals produced, exclusive of iron and steel were: Lead, 20,464 metric tons; mercury, 1,073; copper, 1,839; aluminum, 937 metric tons; silver, 15,254 kg.; antimony, regulus and sulphide, 138 metric tons. The number of working mines was 605, of which 324 were sulphur producers.

The Control of Ore Slimes--I*

By Oliver C. Ralston†

SYNOPSIS—The purpose of this paper is to show that only a thorough knowledge of slimes is required to enable the operator to turn their qualities into advantageous ores, instead of the intractable material they have been usually considered. The principles of colloid chemistry are shown to apply to slimes, and in the light of this information their behavior when handled by various known processes is discussed.

The day of the slimes engineer has dawned. Not so many years ago it was an accepted axiom among mill men that "you must not make slimes in your mill if you wish to save the mineral." But, sadly, whenever men put ore through crushing machinery some "rock flour" was inevitably formed, and slimes soon came to be considered a necessary evil. For years the slimes were run to waste from concentrating mills for the simple reason that there was no known way of concentrating the valuable minerals in them. If the slimes were rich enough to be smelted as a whole, they were so treated, but this was rarely the case, and even then much of the fine material went into the flue dust. Those were the days when we knew little more about handling flue dusts than we did about concentrating slimes.

First Machines To Treat Slimes

Some of the first slimes to yield to any treatment were those from free-milling ores in which some of the gold could be amalgamated, although "flour gold" was soon recognized as a source of loss. The ancient buddle recovered galena to some extent from slimes containing it, and occasionally it did fair work on the recovery of other slimed sulphides. The savings were rarely large, and it was a case of grab all you can. The development of the Wilfley table brought about the invention of slimes tables, recoveries of which were better, but still left much to be desired. Vanners, likewise, have never made recoveries as high as might be desired.

For the time after the introduction of "slimers," we were prone to pat ourselves on the back and say that we now had machinery for the treatment of all sizes of ore. At one end of the line we had bull jigs, and at the other end were vanners and slimes tables. After such pompous talk it is little wonder that many mill men became timid of publication of tailing assays from their plants. Every mill man knew that in spite of the best work that he was able to get out of his slime-handling machinery, he was still getting lower extractions than were desirable. It was only too well known that we were still afraid to make slimes in a mill and that a classification of crushing machinery was made according to whether any particular machine in question made slimes or not. Further, stage crushing was developed in order that a minimum of slimes might be produced in any mill.

Imagine the distrust with which the proposals of the cyanide men were received when it was found that some ores would have to be slimed in order that their values might be liberated for cyanidation. As cyaniding developed into the stage of all-sliming, it broke every supposed rule of the game. The procedure seemed suicidal when the experiences of concentrating mills were considered. Thanks to the fact that gold had a certain fixed price and could always be sold, no matter in what amounts it was produced, the cyanide men went ahead undaunted and developed slime-handling machinery. We have seen settling, classifying, decanting, thickening, agitating, filtering and grinding machinery develop to a stage where slimes can be made and handled cheaply.

These were all mechanical methods and were absolutely necessary before we could turn to the chemical or semi-chemical methods of controlling slimes. We have seen cyanide men use lime as a flocculating agent for making slimes settle faster, and flotation has recently been added to the methods by which we can control slimes. We have found that we can separate sulphide minerals from most slimes by flotation and with recoveries much more nearly perfect than by any of the older slime-handling machinery. In spite of all the appreciation of this new tool, we have not taken sufficient stock of its potentialities. Here is the tool that has really done what slime tables and vanners were supposed to do.

Disappearance of the Dread of Slimes

But the old fear of slimes has been slow to die, and there have been doubters that have said that like all other new methods the promise of flotation will be greater than its fulfillment. This verdict must be withheld for a time, as we have seen flotation expand its field wonderfully in the past two years. We find that it is not only possible to float sulphide minerals, but also metals such as gold, silver and copper, while it is easy to alter oxidized minerals to a condition such that they will float. Further than this, it seems possible to float one sulphide mineral in preference to another—differential flotation.

The significance of these facts is beginning to force itself home, and people all over the mining world are beginning to take stock of the ores that have resisted treatment by ordinary methods. Low-grade and complex ores are becoming popular, for we are beginning to feel confident that we can grind any ore until the particles of the individual minerals are liberated mechanically from one another, and after that we can separate them by flotation or some other slimes process. The advent of the war has stimulated mining in the United States to such an extent that some of these new methods have been put directly into practice. A movement of some magnitude has been made toward the dumps and stope fillings of past generations. This is as good as the opening of new mines, except that the metallurgist reaps the reward.

It is the purpose of this paper to point out a few other methods that seem to promise well in the treatment of

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†Communicated by D. A. Lyon, metallurgist in charge of Salt Lake Station, in coöperation with the Metallurgical Research Department of the University of Utah. O. C. Ralston, assistant metallurgist, United States Bureau of Mines.

This is the fifth of a series of articles treating of "Colloids in Ore Dressing." Former articles appeared in the "Journal" of Feb. 5, Mar. 4, Mar. 18 and Apr. 15, 1916. The sixth will be a continuation of the discussion of this paper, and will appear in an early issue.

ore slimes and to present the results of some experiments in the control of the settling of slimes. The object of these experiments was to gain control of the settling of slimes in such a manner that they could be caused to settle faster, slower, not at all, or else to make one particular set of minerals settle out of a suspension while another set would remain suspended. This work met with notable success in nearly all ways except in differential settling, where only partial separation was attained with one ore and only promised ultimate success.

The Basis in Colloid Chemistry

All of this work has been based more or less on colloid chemistry, and it had been the original purpose of the writer to take up quite thoroughly the principles of colloid chemistry involved. The publication of the series of articles on "Colloids in Ore Dressing" by E. E. Free makes this unnecessary and allows this paper to be shortened. I am obliged to Mr. Free for the privilege of perusing his papers in advance and for the opportunity to publish my paper coincidently with his. Most of his ideas have my hearty indorsement, and this paper may be looked upon as a verification of many of the principles which he has explained. I have already discussed the theory of flotation from the colloid-chemical standpoint[1] as well as a colloid-chemical[2] explanation of the adsorption of gold from cyanide solutions by charcoal and other carbonaceous material.

The present work with slimes has shown that suspensions of fairly coarse material react like those colloidal sols known as suspensoids, even though they settle completely in a short time. It is possible to greatly affect the rate of settling of such ore slimes by the addition of relatively small amounts of the proper substances, which are also known to affect recognized colloids in a like manner. Confirmation of the effects produced can be found in the literature, especially in recent patents.

As an example we may take certain patents of B. Schwerin[3] in which a method of separating magnetic particles from slimes is set forth. Schwerin depends upon suspending the slimes in water and deflocculating them with the proper deflocculating agent in order to break up the little groups of material into individual particles so that the introduction of a magnet will remove only the magnetic particles. He speaks of the deflocculated ore as being in a sol condition, this being a colloidal term that assumes that a colloid is in such a condition that it will not settle out of the suspending liquid. For our purposes the term "deflocculated" (also accepted by colloid chemists) is better, as the only assumption in the word is that the floccules usually present in ore slimes are caused to separate into their individual constituents, even though these individual particles are still heavy enough to settle out of the water on standing. Deflocculation leaves the magnetic particles individually suspended so that they can be removed by means of magnets with a minimum of entrainment of nonmagnetic particles. Deflocculation is obtained by use of electrolytes of basic nature (containing an excess of hydroxyl ions) when the slimes are made up mostly of particles carrying a negative electric charge. Electrolytes of an acid nature (containing excess of hydrogen ions) will likewise deflocculate slimes whose particles are positively charged. Most ore minerals met with are negatively charged, and hence the effect of alkaline electrolytes like sodium hydroxide in making many ore slimes settle more slowly, by deflocculating them, is a well-known phenomenon.

The matter of the reality of existence of the electric charges on suspended particles of matter in liquids can be demonstrated by trapping some of the slimes between two microscope slides and applying a direct current of 110 volts to the two ends of the arrangement, taking care that space is afforded for the gases evolved by electrolysis in such a manner that the movement of the particles will not be affected by these bubbles of gas. By observing the particles with the microscope, they will be seen to move as the potential is applied, and their motion reverses when the current is reversed. Knowing the polarity of the current applied, we find that the particles moving toward the positive electrode must be negative and the negative electrode is the distinction of the positively charged particles. An improved miniature electric cell of this type has been used in my laboratory for a study of the charges on the particles of material that were tested for flotation in a testing machine.

Explanation of Deflocculation

The colloid chemists explain deflocculation somewhat as follows: Suspended colloids have been found to possess the power of adsorbing dissolved substances and ions from solutions in amounts that vary with the different substances involved. Water is somewhat ionized, and substances that are negatively charged when suspended in water, or even in contact with it, have adsorbed more hydroxyl ions than hydrogen ions, and as the hydroxyl ions are negatively charged, the particles show a negative charge. The amount of the electrostatic charge has been measured to be as low as the charge on a single monovalent ion and as large as that on at least a thousand ions, for several typical colloids. If an alkali is added to the water, the excess of hydroxyl ions due to the alkali can be further adsorbed by such a negatively charged particle, and it will repel other similarly charged particles with greater force; or in case they are adhering together in floccules, they become so highly charged that they break apart and the result is deflocculation. Varying dilutions of alkali cause various numbers of ions to be adsorbed onto the surfaces of the suspended particles, giving them greater or less electric charges and causing higher or lower degrees of flocculation. The laws of adsorption are obscure, and we do not know why suspended particles adsorb ions or dissolved substances onto their surfaces and hold them so tightly. It is equally hard to explain why some particular ions are adsorbed more than others. However, the phenomena have been well-enough classified for us to use these various effects intelligently.

Returning now to Schwerin's patents, he describes an experiment in which 1,950 grams of raw ore containing 23.5% Fe was puverized in the wet state until all the particles would pass a screen with ¼ mm. opening, and reduced to a slime by water. To this was added 20 grams

[1] "Why Do Minerals Float?" O. C. Ralston, "Min. and Sci. Press," Vol. CXI, p. 623 (1915).

[2] "Precipitating Action of Carbon in Cyanide Solutions," "Min. and Sci. Press," Vol. CXI, p. 77 (1915).

[3] U. S. Pat. No. 1,063,893 of 1913 and British Pat. No. 19,313 of 1914.

of a normal solution of caustic soda, which deflocculated the components. Part of the ore remained in suspension, and the other part settled out. This latter part was led to a magnetic separator (of the Gröndal wet type) in which the magnetic portion was separated from the nonmagnetic. There resulted 175 grams of magnetic material containing 49.6% Fe and 15.6% sludge. The nonmagnetic product amounted to 775 grams with 9% Fe and 87% sludge. In the suspension, which was not taken to the magnetic separator and whose largest grains were less than $^1/_{15}$ mm. in diameter, a further settlement occurred after some time, amounting to 520 grams containing 37.9% Fe and 29% sludge, while 480 grams of clay material remained in suspension. The 175 grams of magnetic concentrates, together with the 520 grams of settled material, form concentrates weighing 695 grams of 40.6% Fe and 25.6% sludge. This amounts to an extraction of 61.4%. While the work is not particularly good, it indicates possibilities. Further investigation of this process is certainly warranted.

The Essentials of the Murex Process

Another magnetic process that works with suspended slimes is the Murex process, owned by the Murex Magnetic Co., Ltd., of London, and protected by U. S. Pat. Nos. 933,717 of 1909, 959,239 of 1910 and 996,491 of 1911, as well as British Pat. Nos. 25,369 of 1911 and 174 of 1915. These patents were taken out by A. A. Lockwood and assigned to the Murex Magnetic Co. The process depends upon the fact that certain oils adhere to particles of sulphide minerals when suspended in water, in preference to adhering to the rocky gangue particles. The flotation process depends upon the same fact, though utilized in a different way. In this case a finely ground magnetic material, such as iron filings or ground magnetite or pyrrhotite, is mixed into the oil before it is mixed with the ore, and when the oil adheres only to the sulphide minerals we find that these are receiving a coat of "magnetic paint." By using a magnetic separator adapted to slimes separation, such as the Gröndal slimes separator, the particles of sulphides are lifted out of the pulp, away from the nonmagnetic gangue. Material of sizes hardly regarded as slimes, such as particles 2 or 3 mm. in diameter, can also be treated in this way.

The process has been tested out at the Bergwerks-Wolfahrt, near Clausthal, in the Harz Mountains of Germany, as well as at the Whimwell mine in Australia. Fairly satisfactory results have been obtained, though occasionally baffling difficulties were encountered. The magnetic paint, which is made up of oil-gas tar mixed with twice its weight of finely ground cast iron (any animal, mineral or vegetable oil can be used, or even a fatty acid, soap or other such material), is applied in a horizontal rotating cylinder resembling a tube mill except that it is lined with blocks of wood set on end. The mill contains iron or lead shot and pebbles, and the discharge is preferably at the periphery of the end. The metal balls, which are about ¼ in. in diameter, become coated with the paint which they, in turn, rub onto the surfaces of the ore particles. The function of the pebbles is to prevent formation of granules of oiled minerals or any other lumps or agglomerations, and to prevent the shot from sticking together. It is best to give the pebbles a coating of paint before they are put into the mill. The shot are inspected from time to time, and it has been found that so long as they are well coated, the process works satisfactorily. In case the ore requires grinding, the operation can be carried on in an ordinary tube mill.

Some difficulty was met with in the tendency of the ground magnetite or other material to leave the oil and go into the water. One of the patents already mentioned covers a method of preventing this loss of the magnetite by using certain additional agents with the oil when the magnetic paint is made up. When using saponifiable oils, all that is necessary is the use of any sulphate, chloride, sulphide, hydrate or other salt soluble in the oil or which forms insoluble soaps with the oil. In case the oil used is a mineral oil that will not saponify, it will require, in addition to the salt, a small amount of soap or saponifiable oil. A small amount of a solution containing 1 to 5% of alum, mixed with the oil, has been found to do good work.

With some ores it is found that an acid solution works best and with others, alkaline solutions. As a mineral froth does not have to be formed, this process can work through a wider range of solutions than can the flotation process. The plant at Wohlfahrt used a neutral solution and treated a galena ore containing 10% Pb, while the Whimwell plant used an alkaline solution and treated a copper ore containing sulphides and carbonates.

The Wolfahrt plant was discussed by James Hyde.[4] The plant is a 10-ton experimental one and is said to have done such satisfactory work that other plants have been contemplating the installation of the process. A mixture of paraffin oil, pitch, resin and finely ground magnetite is used. A feed of 9,000 kg. of ore per day requires 20 kg. of paraffin oil, 40 kg. of brown pitch and 0.2 kg. of resin, mixed with 72 kg. of finely ground magnetite. The total cost of running this process is about 59c. per ton of ore. The feed averages 6 to 8% Pb and the concentrates 62% Pb and 1.13% Ag. The tailings average 1.1% Pb. Hyde asserts that the American equivalents of the oily materials used will cost less in America than they do in Germany.

The Whimwell plant was forced to do a great deal of experimental work and always seemed to have good chances of success, although there were often unknown adverse conditions that were never completely mastered. The addition of caustic soda to the pulp seemed to be the best general corrective whenever anything went wrong, but so far as I have been able to learn, the plant left many things to be desired. I do not know what has been the fate of this and of the Wohlfahrt plant since the war started.

Basis of the Murex Procedure

The underlying theory of the process is undoubtedly much the same as that of the flotation process, wherein certain minerals are coated with oils while others remain uncoated. In fact, it has not been proved that the Murex process will treat any ore which the flotation process cannot treat unless we except Hyde's statement that under proper conditions it is possible to treat lead carbonate by this process.

In this connection Hyde probably had in mind U. S. Pat. No. 996,491, taken out by Lockwood and assigned

[4] "The Murex Process in a German Works," James Hyde, "Min. and Sci. Press," June 6, 1914.

to the Murex Magnetic Co., in which is given a method of applying the Murex process to the concentration of oxides and carbonates. This consists of the use of a soluble alkaline sulphide in solution to form a film of metallic sulphide over the surface of the carbonate particle by reaction with the same. Thus the reaction with the lead carbonate of an ore is as follows:

$$PbCO_3 + Na_2S = PbS + Na_2CO_3$$

Lockwood gives two examples of the method of working. A 100-lb. lot of ore containing carbonate, phosphate and chloride of lead was crushed to pass a 24-mesh screen and then suspended in 80 lb. of water. To this was added 4 lb. of finely ground magnetite in 2 lb. of Texas residuum oil. After agitation for about 10 min., a solution containing about 3 oz. of potassium sulphide was added. A film of lead sulphide was formed on the oxidized lead minerals, and they were successfully coated with magnetic paint ready for separation in a magnetic separator. The second example is of the sulphide filming of a carbonate ore of copper—likewise successful.

As the sulphide filming of carbonate ores of lead and copper is now meeting with considerable success in the flotation process, it cannot be said that the Murex process has any field that is particularly its own. In fact, there does not seem to be anything the Murex process can do which the flotation process will not do. The greater uncertainty of successful operation of the Murex process, as well as the greater amounts of oils and chemicals used, seems to make it less desirable than the flotation processes.

The Lockwood Treatment Plan

Lockwood[5] has also presented a method of treating fines of mixed materials in order to avoid having to grind them further. Middlings of galena and sphalerite can be treated with a solution of a caustic alkali and silicate of soda, with the result that the galena and sphalerite separate along cleavage lines without the need of further crushing. Supposedly this is due to the tendency of sodium hydrate and silicate to disperse a suspension of negatively charged particles. The increase in degree of dispersion of clays by the use of these chemicals is fairly well known. After freeing the galena and sphalerite in this way, they can be separated on a slime table or on a vanner. He proposes the same method in the tabling of mixed zinc-lead flotation concentrates.

Lockwood gives, as an example of this method applied in the treatment of an ore, two tests that were run on

SEPARATION BY USE OF SODIUM HYDROXIDE

Concentrates				Middlings
Wt., Lb.	Size	%Pb	%Zn	Wt., Lb.
103.5	On 60	76.8	3.9	43.5
172.0	On 80			36.5

COMPARISON BY USING PURE WATER

Concentrates				Middlings
Size	Wt., Lb.	%Pb	%Zn	Wt., Lb.
On 60	88	72	6.5	130
On 80	134			68

two tons of ore from the Broken Hill Proprietary. The ore was crushed to about 40 mesh and divided into two lots. One lot of 2,240 lb. was treated with 500 lb. of a solution containing 5% of caustic soda and 1% of sodium silicate. After agitating for 30 min., the pulp was fed onto shaking screens, and the material remaining on the 60- and the 80-mesh screens was run over vanners. The results are shown in the first table. With the other lot of 2,240 lb. the same conditions were observed except that pure water was used on the ore instead of the dispersing agents. The results are tabulated for comparison.

Lockwood examined the middlings in each instance and found that in the case of the dispersed pulp they seemed to be made up of free crystals of galena and sphalerite, while the middlings from the test in water seemed to be true middlings, containing composite particles of the two sulphides that required further grinding. Just how he did this is not mentioned, and I am inclined to doubt that true middlings were actually broken up by the sodium compounds. It is thoroughly possible that floccules containing both sulphides could be dispersed by the sodium salts and that it was hence easier to get a good clean tabling test on this account. The idea certainly merits further investigation.

Schwerin's Electro-Osmosis Theory

One particularly interesting method of controlling slimes of all descriptions has been described by Count Botho Schwerin, a citizen of Germany, in a number of patents[6]. Schwerin has been instrumental in the application of colloid chemistry to many problems, among which are the dehydration of peat and other organic materials, the purification of clay, the production of special ceramics, the concentration of various ores, etc. It has been found that many suspensions of clays with their impurities can be purified by utilizing the fact that particles of colloids, when suspended in water, will migrate toward one or the other of two electrodes introduced into the suspension, depending upon the sign of the electric charge carried by the particles. Direct current is used, and since most ordinary particles found in ores will be found to be negatively charged, they migrate toward the anode. As mentioned earlier in the paper, we are able to control these charges by the use of the proper electrolytes added to the suspensions and thereby control the direction in which they migrate and the speed at which they migrate. The water migrates in the opposite direction, and if the particles are congealed into a gel or into a porous diaphragm, the water can still migrate when the electric current is passed. This travel of the water is known as electro-endosmosis, or electro-osmosis. It was first noticed in electrolytic cells containing porous diaphragms, such as have been used in the electrolysis of brine solutions for the formation of chloride and sodium hydrate. The motion of the particle through the liquid is known as electrophoresis. When a particle migrates toward the anode, the phenomenon has been called cataphoresis and when it migrates toward the cathode, the phenomenon is anaphoresis. The word cataphoresis is often used in place of electrophoresis for the reason that the commonest particles met usually have a negative charge.

One special application of this migration of particles and water is in the purification of clays. This process has been described by Ormondy[7] in the purification of English clays, and by Bleininger[8] for American clays. The impure clay is made up into a "slip" of the con-

[5]U. S. Pat. No. 956,381 of Apr. 26, 1910.

[6]Nos. 670,351, 720,186, 894,070, 993,888, 1,027,004, 1,029,579, 1,053,303, 1,098,176, 1,120,551, 1,121,408, 1,121,409, 1,133,967 and 1,156,715; British Pat. Nos. 24,670 of 1904, 3,364 of 1911, 2,379 of 1911, 11,626 of 1911, 27,930 of 1911, 27,931 of 1911, 28,185 of 1911, 23,545 of 1912, 24,666 of 1912, 14,369 of 1912 and 11,823 of 1914; German Pat. Nos. 239,649, 249,983, 251,098, 252,370, 253,429, 253,931, 265,628, 266,825 and 272,383.

[7]"Trans. Eng. Ceramic Soc.," Vol. XII, pp. 36-64 (1912-13).

[8]"Trans. Am. Ceramic Soc.," Vol. XV, p. 335 (1913).

sistency of thick cream, by the use of water, and is preferably deflocculated by the use of a little sodium hydrate. The coarse particles, as well as some of the iron minerals present, separate out by sedimentation. The suspension is run into a metal trough into which dips a revolving horizontal cylinder made of lead or type metal. The cylinder is made the anode and the trough the cathode for the passage of an electric current under 110 to 220 volts. Bleininger[9] gives a photograph of a laboratory machine of this type, and Schwerin[10] gives a sketch of a larger machine.

The Migration Principle Used for Slime Filtering

Under the influence of the current the clay is deposited on the type-metal cylinder, which rotates slowly, and the deposited blanket of pure clay (this deposit is about 1/4 in. deep) is scraped off at the top by a scraper. This clay contains about 17% moisture, which is less than that remaining after filter-pressing with a pressure of 2 tons per sq.in., and the clay is whiter and more plastic than the impure original clay. The velocity of migration of the particles is about 43×10^5 cm./sec./volt/cm., which is about the same rate as that of many ordinary ions in solutions. Hence the clay slip requires stirring to bring the particles in contact with the cathode in large enough numbers to prevent water being electrolyzed by the current instead of the particles being deposited. The cost of current in England for the depositing of a ton of clay is from 10 to 64c., and a plant capable of producing 40 tons per week of finished product will cost $25,000.

Bleininger is of the opinion that the greatest use of this machine will be as a substitute for the filter press, and recent experiments seem to bear out that opinion. Most of the impurities of the clays are removed during the period of sedimentation preceding the electrophoresis, and the only function of the electrical operation is to remove the clay particles from the suspension in a fairly dry state. When very colloidal ore slimes are encountered which seem to resist all attempts at filtration, this method of collecting may prove useful. Experiments with ordinary free-settling slimes by this method have been carried on in my laboratory and have shown that most of the particles are too large to be handled effectively by the method. With a clayey ore capable of a high degree of dispersion, better results can be obtained, although they are still far from what can be done with the true clays.

In passing it might be well to call attention to the fact that Schwerin's patents contain a wealth of information on the properties of various suspended particles and on methods of controlling them. He finds, for instance, that a particle more or less indifferent toward the electric current can often be electrified into life by the addition of some colloid body, such as colloidal silicic acid, and a deflocculating agent, like sodium hydrate. The colloidal silicic acid is adsorbed on the surfaces of the indifferent suspended particles, and the resulting composite particles are more active. Sodium silicate will hydrolize into silicic acid and sodium hydrate; hence it is at once a combined activating and deflocculating agent. In another place he mentions the fact that with a well-deflocculated suspension the consumption of electric energy is less and the speed of the particles greater.

[9]Technologic papers of the Bureau of Standards, No. 51.
[10]U. S. Pat. No. 1,333,967.

The importance of the investigation of all these colloidal phenomena in their bearing on the control of ore slimes need not be magnified. They are mentioned in the hope that further research will be instigated by parties who can profit by the results of such investigation.

The Settling of Slimes

Most of the original work to be reported in this paper deals with the subject of slimes settling, the original object of the work having been to control the rate of settling of ore slimes by the application of the principles of colloid chemistry. As previously mentioned, it has been possible to make almost any ore slimes settle faster or slower, and some success has been attained in differential settling in a few instances.

The use of lime for the flocculation of low-settling slimes has been common practice among the cyanide operators, and many a cyanide plant would not be able to work without the use of lime. Slow-settling slimes in which the individual particles can hardly be distinguished, can often be caused to gather into large floccules by the addition of small percentages of caustic lime. These large flocks settle out with much greater speed than do the small individual particles. Nicolai[11] gives the results of recent work in Germany on the clarification of muddy mill water by the use of magnesium chloride, a waste product from the potash works. Magnesium chloride is a very effective coagulant.

The idea of deliberately causing an ore slime to settle more slowly does not seem to have been applied by anyone. There are, however, conditions under which such deflocculation of a slime could be utilized, aside from those already mentioned. For instance, the work reported here shows that it is possible to deflocculate the so-called true slimes so that the coarser material can settle out of the suspension separately. This would be the ideal separation of nonleachable material from leachable sands, which the Dorr and similar classifiers approximate. Under these conditions the sands that settle will not be coated with entrained slimes. In fact, the Dorr classifier could be used to make the improved separation.

Another application of deflocculation to slimes could be in the problem of transportation of slimes through launders over considerable distances on level ground. When deflocculated, the slimes do not tend to settle out so badly, and on arriving at their destination they could be flocculated and deposited by the use of the proper agent. Ditches that have become clogged with settled clays ought to be opened up by occasional flushing with water containing a deflocculating agent, while the settled material can be loosened by drags. The use of lye to open clogged drain pipes is a matter familiar to everyone. Deflocculated clay slips have much less viscosity than ordinary clay slips, and a piece of damp clay will almost liquefy upon the addition of small amounts of the proper alkalies. With these points in view, there seemed to be a sufficient encouragement for the following series of systematic investigations.

Owing to the fact that the chief interest of the mill man lies in the rate at which he can draw off clear water from a thickening tank and what will be the percentage of solids in the thickened pulp, the following method was used in the study of the rate of settling of slimes:

[11]"Metall und Erz," Vol. III, pp. 135 and 155 (1915).

A series of 200-c.c. graduates of approximately the same size was obtained, and weighed quantities of ore were introduced into the graduates, which first were partially filled with water. The rise of the water surface on the introduction of the ore allowed a measure of the volume of the ore, and knowing its weight and volume, the density of the dry ore could be calculated. The graduate was then filled to the 200-c.c. mark. By placing the hand over the mouth of the graduate and inverting and shaking several times, it was possible to suspend the ore homogeneously in the water before the graduate was put down and settling allowed to begin. The rate of subsidence of the surface of the settling slimes was then noted. As the particles in the suspension have zero velocity at the beginning, the rate of subsidence of the slimes surface increases to a maximum and then diminishes as the density of the thickened pulp increases, causing the particles to get more and more in one another's way. In Free's series of papers we find that he observed the position of the surface of the consolidated slimes in the bottom of the graduate, instead of the surface of the sinking column of thickening slimes. Either method

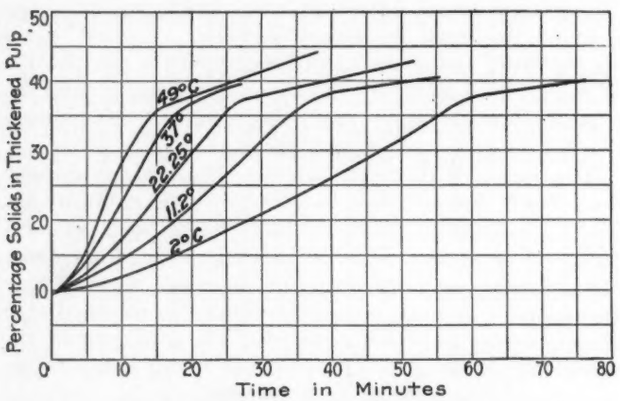


FIG. 1. COMPACTING SETTLING

gives us an idea of the average rate of settling of the slime particles.

With dilute suspensions, the larger particles tend to drop out first and the smaller particles gradually thin out of the upper layers of the water so that no definite upper surface of the thickening slimes is formed. However, with most ore slimes this is only a tendency, as the smaller particles sink with a measurable velocity and the surface of the thickening slime will be indistinct and hazy, owing to these slowly settling particles tending to cloud the clarified water above. Later this hazy surface of the thickened slimes, at a perfectly definite position and at a perfectly definite time, will suddenly change to a sharp line of separation between the settling slimes and the clarified water. Shortly after this the rate of settling of this surface will fall off greatly. With slimes containing more and more solids at the beginning of settling, the position at which this line appears is higher and higher up in the tube, although it takes a measurable length of time for any previously agitated slime to consolidate to a condition such that a definite line of demarcation can form. With thick slimes and when well flocculated, the line appears in a few seconds and practically at the surface of the water.

This difference in behavior between dilute and concentrated suspensions is undoubtedly due to the fact that in the dilute suspensions the particles fall individually, while in the concentrated suspensions they seem to settle collectively. The particles, when falling individually, exhibit the greatest speed of settling. In Free's papers I find much the same observation. He has termed the two types of settling "subsidence" and "consolidation" settling. In order to avoid confusion of nomenclature, I have adopted Free's terms in the following discussion. Nearly all the dilute suspensions of ore slimes that I have studied begin to settle by subsidence until at a definite concentration of solids the line appears and consolidation settling begins. With most commercial pulp-densities subsidence settling takes place only to a limited extent unless the slimes are deflocculated. It is rare that the mill man meets as slow settling a slime as Free's kaolin suspensions.

In addition to the two types of settling already mentioned, I have observed a third, for which I propose the

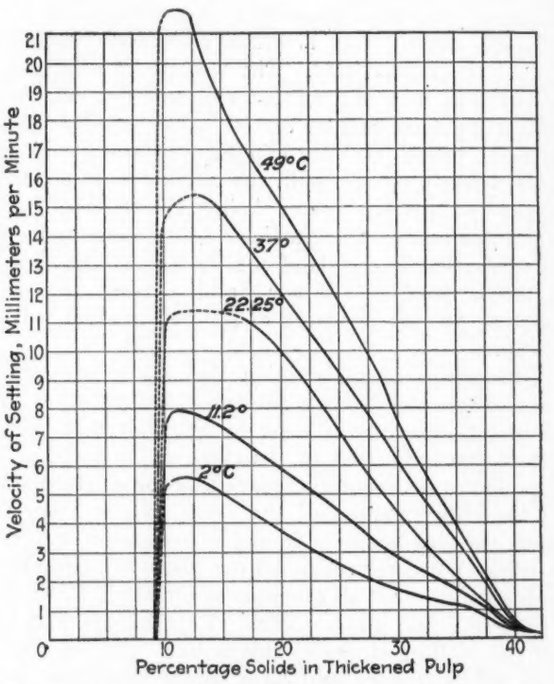


FIG. 2. ANOTHER ILLUSTRATION OF COMPACTING SETTLING

name "compacting" settling. With most freely settling ore slimes, this type of settling sets in at about 40% solids, illustrated in Figs. 1 and 2. During this phase of settling, the thick material in the bottom of the graduates seems to be slowly rearranging itself into closer packing. The rate of settling during this phase is always considerably slower than during consolidation. When long settling tubes are used, the material that has settled onto the bottom first is well compacted by the time the column of slimes above it has reached the consolidation stage, and hence sonsolidation shades imperceptibly into compacting. Only short tubes showed this particular phenomenon, and as Free's work was with long tubes, his results do not show the compacting stage. In my own work the compacting was very evident in the 200-c.c. graduates, which were about 10 in. deep. It was not observed in a tube giving a column of 36 in.

Roughly speaking, most ordinary dilute slimes will settle by subsidence until the thickened material reaches

about 10-20% solids, at which point the surface of the settling material suddenly becomes clear-cut and the settling enters the consolidation phase, which it pursues until the pulp contains an average of about 40% solids, where it enters the compacting phase. Some decrease in velocity is noticed on passing from the subsidence to the consolidation phase, but a great decrease in velocity often takes place on passing into the compacting phase. As will be seen later, the effect of the addition of electrolytes and of colloids is to shift the critical, or transition, points (where the settling changes from one phase to another).

The only feasible explanation of the difference between subsidence and consolidation settling would appear to be the following: In dilute suspensions the larger particles of the slime would tend to settle relatively faster than the others, and in dilute suspensions they can go down without entraining smaller particles; so the latter are left behind to settle more slowly. The water above the subsiding slimes is hence always somewhat cloudy. With more concentrated suspensions it is possible to reach a consistency in which the distance between the larger particles is so small that the particles of smaller size are trapped and carried down. This suspension of the larger particles might be regarded as a filter for the suspension of the smaller particles.

In the tests in the graduates it was possible to read only the approximate situation of the hazy surface of slimes settling by subsidence, but it was easy to read the exact position of the sharp line of demarcation between clear water and slimes settling by consolidation. By taking readings at appropriate intervals, it was possible to get the rate of settling of the slimes surface, and it is this velocity which is referred to hereafter.

British Miners and the War

The condition of miners serving in the British army has come in for some careful consideration by the Institution of Mining and Metallurgy. An effort is being made to secure the return of such men to their former positions when their service shall have been finished, with provision for the utilization of those who have been injured. The following letter sets forth the attempt of the Institution to provide for the future:

TO THE BOARDS OF DIRECTORS OF BRITISH MINING CAMPS

The Council of the Institution of Mining and Metallurgy feels it incumbent upon it respectfully to request your serious attention to an important aspect of the effect of the war upon the British mining industry.

A very large number of British mining engineers and metallurgists are, as you are no doubt aware, on active service with His Majesty's forces in the various theaters of war, and as evidenced in official despatches and in the number of distinctions awarded to them, they have demonstrated their ability and heroism.

Nearly 700 members of this Institution alone are on active service, and there are very few British members of military age and fitness remaining in civil employment in any part of the world, and of those some are known to have been forbidden to leave their present work because of the necessity of maintaining the output of gold and other metals of vital importance in the prosecution of the war.

It is a melancholy fact that many have already made the final sacrifice, while others have been permanently maimed. The Council is deeply concerned for the welfare of those whose lives may be spared, and feels sure that in most cases mining companies will make such arrangements as will facilitate the return of the members of their technical staffs to their former positions on the termination of the war.

It would indeed be a poor return for the sacrifices British mining engineers and metallurgists have made in the defense of the empire and the cause for which the allied nations are fighting, if on their return to civil life they found their positions occupied and their means of livelihood gone. The Council begs you, therefore, to keep this aspect of the war in view and to make every provision for the employment of British mining engineers and metallurgists in your mines and works after the termination of the war.

The Council will be gratified to learn that boards of directors are in accord with it in this matter, and it trusts that in the present circumstances they will accept this communication through the press in place of a direct letter to individual companies.

New Honduran Mining Law

Reference was made in the *Journal* of Mar. 4 to the new mining law that was under consideration in Honduras. This bill was passed by the Honduran congress on Feb. 15 and contains some interesting provisions. Some of these, translated by United States Minister John Ewing, of Tegucigalpa, and communicated to the Bureau of Foreign and Domestic Commerce, are reproduced here:

Art. 1. The law grants to individuals the rights of property to mines under the condition that they shall work and develop them constantly in conformity with the provisions of the present code and with the regulations which may be issued. . . . . Mines shall be forfeited, as being considered unoccupied, when conditions set forth in the following articles are fulfilled:

Art. 6. Mines are considered unoccupied: (1) When for one consecutive year four men at least have not been working in them, either upon interior or exterior work really connected with the development thereof. (2) When the work of four workmen is alternately stopped without any one suspension amounting to a year, so that the mine will be unworked 400 days in two years, counting from the first day of the stoppage of work.

Art. 9. A mine cannot be declared unoccupied when the stoppage of work results from unavoidable reasons, such as absolute lack of workmen, war, famine or pest in the region in which the mine is located.

Art. 10. Persons may suspend the working of their mine for two years without being liable to having it declared unoccupied, if they have worked it uninterruptedly for two years, by paying for the time they plan to be idle, counting from the time work is stopped, a tax of 10 pesos monthly. . .

Art. 12. A mine will be considered unoccupied when the house and indispensable offices formerly constructed for the use of the mine shall have been destroyed or become absolutely unserviceable, etc.

Art. 28 limits the amount of territory that may be granted as a mineral zone to 200 hectares (492.2 acres), and Art. 32 provides that mining concessions cannot be granted for locations where a mining town has already been established.

The law will go into effect July 1, 1916. Owners of mineral zones shall have to pay for each hectare of their property an annual tax of 25 centavos; mines will pay 3 pesos per hectare. An additional article provides a tax of 5% ad valorem on gold or silver exported and a tax of 10 pesos on each ton of precipitates leaving the country—five tons may be exported free for the purposes of analysis.

Odd Case of Arsine Poisoning

A peculiar case of arsenic poisoning is noted in the recently issued report for 1914 of the British Chief Inspector of Factories and Workshops. The workman had been cleaning out a saturator in an ammonium-sulphate plant and had placed an acid residue containing a large amount of arsenic (apparently derived from the sulphuric acid used) in a galvanized-iron pail. The acid in the residue reacted with the zinc lining and arseniureted hydrogen was formed by a secondary reaction, thereby poisoning the workman. Only wooden or fiber pails should be used for such work.

Black Hills Gold-Bearing Iron-Quartz-Tremolite Belt*

By B. M. O'Harra†

SYNOPSIS—Iron-stained quartzite belt between Deadwood and Lead believed to have close relation to great Homestake orebody. Structural details complex. Influence on ore deposition great. Series has economic importance and gives promise of further importance.

The iron-stained quartzite, outcropping in a prominent manner between Deadwood and Lead in the Northern Black Hills and known among mining men of the region as "The Great Iron Dike," has long excited interest and speculation.

This quartzite is closely associated with certain characteristic tremolitic schists, graphitic slates and sulphide bands, the whole making up a fairly well-defined rock series. The series is of interest because of its mineral content and because in the Northern Hills it is believed by some to have a close relation to the great Homestake orebody a short distance away.

Character and Distribution

The rocks are of Algonkian age. They stand generally at a high angle and may be traced across the country for several miles in a nearly due north-south direction. Southward a large irregular area of Paleozoic sedimentaries and Tertiary igneous rocks conceals them. Farther south, beyond this covering, there is a much larger area of Algonkian rocks, and this is traversed by a series of rocks much resembling the series of the smaller northern area. The tremolitic portion of this southern series has long been known as "The Hornblende Belt." There is much reason for believing that the two series are identical and that they represent one continuous mineralized zone. As neither of the two local terms named is serviceable for the entire distribution and as quartz, tremolite and iron sulphides (iron oxides in the weathered zone) are prominetnly characteristic throughout, I designate the entire zone as the Iron-Quartz-Tremolite Belt. The structure in both the northern and the southern districts is complex; in fact, the structure in the Rochford district is perhaps more complex, or at least more difficult to interpret than in any other part of the Black Hills region. On the accompanying map the long irregular boundary line represents the contact between Algonkian and post-Algonkian rocks as published by the United States Geological Survey. The main areas within and south of this line are of Algonkian age. In the northern district considerable areas of the later rocks are Tertiary eruptives. The others are Paleozoic and post-Paleozoic sedimentaries.

Study of the northern district was confined particularly to the area lying east of a north-south line drawn through Lead. East of the Homestake, two outcrops of the quartz-tremolite rock were found. They strike nearly due north and south and stand nearly vertical, one outcrop running just west of Deadwood, the other just east of Lead. The hard iron-stained quartzite forms a series of prominent peaks, with the tremolitic and pyritic material running along the eastern slopes in the Deadwood outcrop and on the western slopes in the Lead outcrop.

The most complex portion of the Rochford district was covered, and the map is believed to show the relations fairly accurately, except that further study may show extensions not here represented. The fact that the various outcrops are not continuous indicates only, except in the case of the quartzites, that there was not time or opportunity to trace them further. In this district the several nearly parallel outcrops strike about N 25° W and dip 60 to 80° E. Two outcrops west of Myersville are exceptional in that they strike more to the west and dip about 50° E. The various members of the series commonly show characteristic topographic features, among which especially is the depression extending from near Myersville to the Bulldog Ranch and occupied much of the distance by the north fork of Rapid Creek and the Burlington railroad. The bedrock here is composed largely of soft graphitic slates carrying pyrite.

In general, the quartz-tremolite portion of the series may be said to be made up of chloritic and garnetiferous tremolite schists with numerous quartz stringers and lenses running through it. The schistosity runs par-

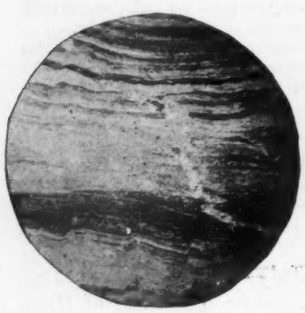


Fig. 1

Fig. 2

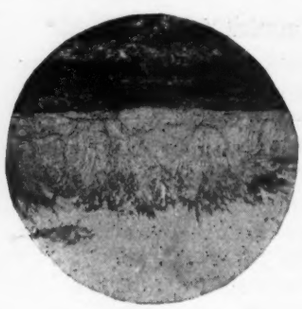


Fig. 3

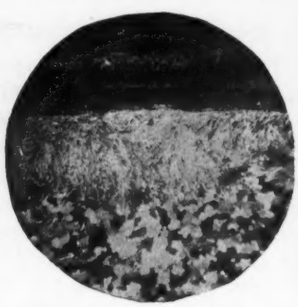


Fig. 4

THIN SECTION OF QUARTZ TREMOLITES

Fig. 1—Crumpled quartz-chlorite schist cut by thin quartz stringer. Fig. 2—Contact between quartz stringer and rock mass of biotite and calcite. Figs. 3 and 4—Contact between quartz lens and rock mass with tremolite fringe along contact

*Excerpt from a thesis presented at the South Dakota State School of Mines.

†Rapid City, S. D.

allel or nearly parallel to the original bedding planes. The rocks are usually much contorted and in some places considerably cracked and shattered. In the Northern Hills the garnets and tremolite are most prominent and in the Rochford district, the quartz and tremolite. By far the greater amount of quartz is in stringers and lenses running parallel to the schistosity. These are evidently an original feature of the schist and independent of the later disturbances. During these disturbances there was formed a series of crevices that were filled with quartz, and in this way there was developed a second class of veins, cutting across the plane of schistosity.

The tremolite is the most persistent feature of the series. This occurs in radiating star-like clusters, sometimes tightly pressed together to form the greater part of the rock, at other times scattered through a quartz or chlorite schist. When nearly the whole of the mass is made up of tremolite, it gives rise to a crinkled sort of rock known to the miners as curly-stone. This is very tough and almost impossible to break with a hammer.

The tremolite, when forming only a minor portion of the rock, is very difficult to detect until one becomes familiar with it, but with a little experience it may be recognized even after oxidation has left little of the original material.

Associated with these tremolite schists are bands of soft graphitic and pyritiferous slates and massive iron-stained quartzites. I have included these in the series.

The most prominent members of the iron-quartz-tremolite belt in the Northern Hills are the two bands of massive iron-stained quartzite that form the so-called "Great Iron Dike." These outcrop several hundred yards west of the city limits of Deadwood. They are separated by about 200 ft. of softer schists and slates. They have had an important influence on the topography of the country, forming a series of quartzite capped peaks extending for several miles in a south-north direction between Deadwood and Lead. In the unoxidized portions, as exposed in underground mine workings, these consist of a very white quartzite, heavily impregnated with pyrite, pyrrhotite and arsenopyrite. In the weathered zone the sulphides are oxidized to hard red hematite and brown limonite, giving the quartzite a dark-red or brown color. The iron stain sometimes occurs in parallel streaks, with layers of the pure-white quartzite between. Since the quartz-tremolite rocks are softer and usually are concealed by talus except where some artificial cut (as for example, for a railroad or wagon road) exposes them, the quartzites are a great help in following the outcrop of the series.

Another portion of the belt that has attracted considerable attention is that known as the "Copper Pyrite Dike." This is a series of several bands of pyritic material, varying from a few inches up to 5 ft. in thickness. It lies near the eastern edge of the tremolite outcrop just west of Deadwood. The pyritic material carries some gold and copper and has been much prospected for these, but its only economic importance so far has been for pyrite for smelting purposes. Several years ago a great deal of this was mined and used at the Golden Reward smeltery, in treating the blue siliceous ores of the Ruby Basin-Bald Mountain district. At the surface this material is oxidized to a very soft, black, spongy material containing some graphite, forming a typical iron hat. A white or greenish coating of melanterite is often present.

Most of the tremolite and garnet rock lies between the quartzites and the pyrite, though some tremolite is found just east of the pyrite. The garnets are more prominent here than in any other locality. The garnets and tremolite are in bands alternating with each other and with bands of quartz and mica schists. The tremolitic bands vary up to several feet in thickness. The garnet bands are somewhat thinner. The garnets range from the size of a pinhead up to an inch or more in diameter. Those in any one band are usually fairly uniform in size. In some places they are scattered through the tremolite, causing knot-like protuberances, in others they form the greater part of the rock. One layer 4 in. thick was noticed, made up of garnets averaging half an inch in diameter, all tightly pressed together.

The chief differences between the series near Deadwood and the rocks in the Rochford district are the great abundance of garnets, the much smaller amount of quartz present and the thin selective banding. Occasional lenticular masses of quartz are found, especially along the western side of the tremolite members, but the numerous stringers and lenses of the Rochford locality are not characteristic here. There is also much less crumpling and contortion than at Rochford.

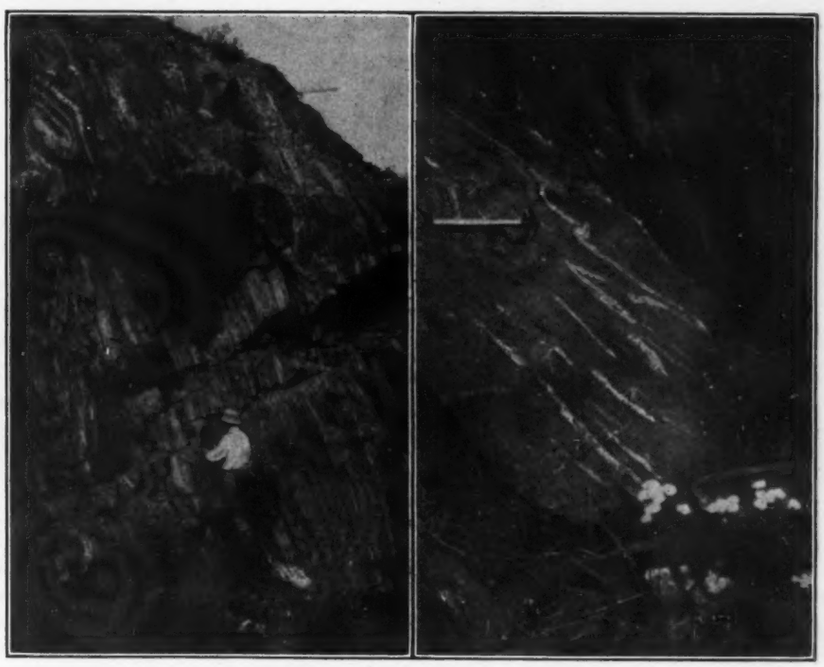


FIG. 5. QUARTZ TREMOLITE EXPOSED NEAR ROCHFORD, S. D., SHOWING SHARPLY FOLDED QUARTZ VEINS

In the observed outcrops near Lead, the quartz stringers become more abundant and the garnets less prominent, but the amount of tremolite also decreases. Here the iron-stained quartzite is east of the tremolite instead of west. This might suggest that the two outcrops are the exposures on the two sides of a fold, though with the amount of in-

formation at hand this can be only a conjecture. In the railroad cut at Blacktail station some small stringers of calcite were found, one vein having calcite on one side and quartz on the other.

Exposures in the Rochford District

The iron-quartz-tremolite series in this district is characteristically a fairly massive tremolite schist with a great abundance of quartz in the form of stringers and lenses. Garnets as a rule are not numerous and when found are of small size. The tremolite, in the most typical exposures, is in the form of an aggregate of star-like clusters, making up, with the quartz, almost the whole of the rock. Exposed faces are usually stained dark brown by iron oxide.

The quartz shows all gradations from thin continuous bands to lenses with an almost round cross-section, indicating that the lenses are only a particular phase of the bands. The bands and lenses vary from ½ to 2 in. in thickness. Where pressure and contortion have been great the quartz often has a sugar-like texture and will sometimes even crumble in the fingers like soft sandstone. These stringers and lenses that have just been described all run parallel to the schistosity and cause the folding and crumpling that have taken place to show very prominently. In addition to these there are many quartz veins and veinlets that cut across the plane of schistosity at all angles, the majority running nearly perpendicular to it. They show little contortion and are apparently of later date than the folding. They frequently carry much pyrite and arsenopyrite.

FIG. 6. HORNBLENDE BELT OF ROCHFORD DISTRICT

The folding and cross-veining is very complex in the vicinity of Rochford, presenting many interesting features. A peculiarity is the fact that one zone a few inches thick may be sharply folded, while a zone of exactly similar material three or four inches from it will show no disturbance or may be folded in the opposite direction. There are often veins or local deposits of calcite or aragonite and siderite lying along the edges of the lenses of quartz, and veins of aragonite running across the plane of schistosity are not uncommon. One nearly horizontal vein varying up to a foot in thickness and entirely filled with beautiful snow-white aragonite may be traced for several hundred feet in the open cuts of the Standby mine.

The quartz lenses and stringers often have a layer of tremolite $\frac{1}{16}$ to ¼ in. thick on each side. This is made up of asbestiform fibers arranged perpendicular to the surface of contact and sometimes between the two there is a layer of pyrite.

In places where gold content higher than the average is found, the tremolite becomes less prominent and chlorite becomes abundant. This suggests that the gold-bearing solutions produced an alteration of the tremolite and associated iron-bearing minerals to chlorite.

Black, very graphitic slates, frequently carrying much pyrite and arsenopyrite, are nearly always found in close conjunction with the tremolite members and probably correspond to the graphite-pyrite series of the Northern Hills exposures. This graphite sometimes approaches a marketable grade.

The characteristically prominent iron-stained quartzites of the Northern Hills are not found in the Rochford district, though there are many quartzites more or less associated with the tremolite members. Some of these are highly iron-stained. The majority are nearly pure white and approach the appearance of vein quartz. Others are very coarse and of a gray color. Their relations are not clear, they normally cannot be traced far, and they are apparently not very continuous.

Economic Importance of the Series

The rock series herein described has received much attention since the earliest days of lode mining in the Black Hills. It has been much prospected, and in a number of places fairly extensive work has been carried on. It happens that the mineral contents generally are not high, and although gold is present practically throughout the tremolite portion of the series, milling returns have in most instances been too low to warrant long-continued production. Without doubt the series played an important part in the gold deposition of the Black Hills, and in the minds of many men there is good reason for believing that under favorable conditions properties well-situated could be made into good paying mines. At the present time, just as in the years of the past, considerable development work is being done. Among the better-known properties of the Rochford district are the following: Yellow Bird, McKinley, North Star, Mercedes, Black Eagle, Golden West, Cochran, Balkan, Standby, Gordelia, Ray, Ohio, Montana, Montezuma.

Of these the Standby, the Montezuma, the Cochran and the Golden West have perhaps been most extensively worked. Much of the ore obtained has been mined from open cuts. Occasionally some very rich streaks are found. The more favorable places have usually been those where numerous quartz stringers run across the strike of the schistosity. Chlorite is generally abundant in such places.

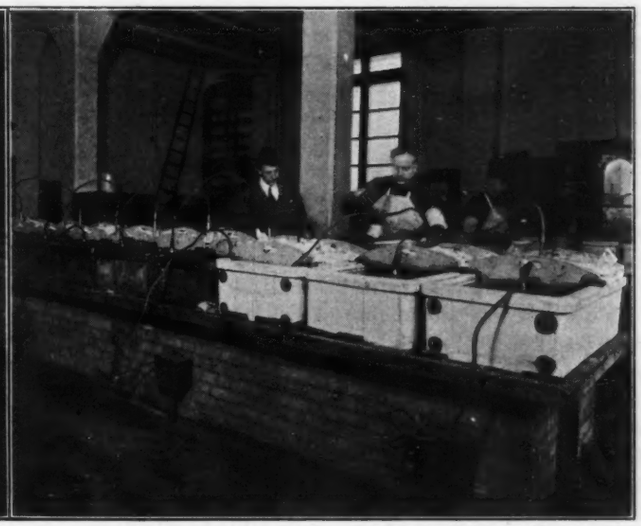
The series commonly known as the "Great Iron Dike" and that known as the "Hornblende Belt" are evidently continuations of the same general series. This consists of metamorphosed sandstone, shales and impure limestones. The limestone was first altered to a rock composed principally of tremolite, calcite, quartz, biotite and garnet. It was later greatly fractured and contorted by dynamic movements, the fractures allowing the entrance of solutions that deposited the transverse quartz and aragonite veins, impregnated the surrounding rocks with sulphides and with gold, and caused the alteration of the biotite and associated minerals to chlorite. The series has a certain known economic importance and gives promise of further future importance. The influence on ore deposition has been great and the structural details are very complex.

Gold and Silver Refining

In the Wohlwill gold-refining process a solution carrying 25 to 30 oz. of gold and 25 to 30 oz. of free hydrochloric acid per cu.ft. is usually used. A sheet-gold cathode is ordinarily employed, and a current density of about 100 amp. per sq.ft. The drop across the tank is usually about 1 volt, the temperature being held at about 60° to 70° C. The high acid content is necessary to keep the solution from depleting rapidly in gold, and even then it usually does so slowly. The platinum contained in the gold bullion remains in the electrolyte and is eventually recovered from it. The silver is left in the form of silver-chloride slimes. If lead is present in the anode, a little sulphuric acid is added to the electrolyte to cause it to slime also.

In the Thum process of silver refining, anodes are held in cloth-lined baskets placed in tanks made usually of porcelain. A carbon bottom forms the cathode, the silver being deposited in noncoherent form and scraped off. The electrolyte is a 5% silver-nitrate solution carrying about 0.1% free nitric acid and some copper. The current density is usually 30 to 40 amp. per sq.ft., and the e.m.f. per tank 1.4 to 1.5 volts. The gold and platinum remain as a slime in the filter-cloth lining of the basket, and the copper dissolves in the electrolyte, which must eventually be discarded on that account. The accompanying illustrations show both processes.

THE WOHLWILL GOLD-REFINING PROCESS



OPERATING THE THUM REFINING PROCESS

British Patent Laws

The Patents Act of 1907 with the Act of 1914 and rules made thereunder—after the war had begun—are said to be responsible for the following present grievances according to *Journ. Soc. Chem. Ind.*, Feb. 29, 1916: (1) The Comptroller of the British Patent Office has not apparently the power to refuse acceptance of any application for a British patent, even although a patent for the identical invention may have been granted and published years before in a foreign country. (2) Any German desiring to appropriate a British invention for which a British patent has been granted to a British inventor, may do so in the following circumstances: Supposing the British inventor applies within 12 months for a patent in Germany for his invention, his application may be successfully opposed there on one ground or another and a decision issued in circumstances such that the British applicant cannot secure a hearing. In the case of an opposition to a British application of a German subject, proceedings are postponed to the end of the war. (3) Under the 1907 Patents Act, anything known or unknown for which a patent is applied in this country, however impracticable (for which a British patent specification has not been filed in the British Patent Office Library during 50 yr. before the date of application), is entitled to British patent protection—51 yr. anticipation does not count.

It is urged that in the revision of our patent system (foreshadowed recently by Mr. Runciman, the president of the Board of Trade), there should, among other things, be included: (1) A real search to insure novelty and validity, before any application for a patent be entertained. (2) No patent to be granted unless novel or practicable. (3) The entire abolition of all renewal fees. (4) The extension of the period for each patent from 14 to 17 yr. (5) Some form of a guarantee for a *bona fide* inventor. (6) Simplified court procedure in patent cases, so as to limit the heavy expense of patent litigation. Moreover, in the formulation of any new patents act, inventors, engineers and business men should be called into consultation more than patent counsel, lawyers and patent agents, as has hitherto been the case, which is a desideratum in any country.

Details of Practical Mining

Three Shaft-Sinking Methods

By Albert E. Hall*

Three methods are here given of shaft sinking below ground, or rather, of sinking and raising, all of which seem to have worked well at the different mines where they were employed.

The first method was used at the Crean Hill mine, Ontario, Canada. This shaft was inclined at 68°, and while 24x8 ft., the work was done in halves, each 12x8 ft. Two bars were employed with only one machine in each bar. To give a break in the first half 22 holes were needed. A double cut was used, but only four holes were drilled in the first cut, while six were needed in the outside cut. Six holes on each side, numbered 3 on Fig. 1, made up the rest of the round. The four first cut holes marked 1 were first fired. The second set of six cut holes, marked 2, were fired next; when the shaft had been mucked out, the rest of the round was fired. The cuts usually pulled about 7 or 8 ft., using about 450 to 500 sticks of gelignite to the round. The holes were fired by battery. The shaft was sunk in schist, and the cost was from $22 to $25 per ft. for one half.

Mucking was done into a bucket pulled to the level above by an air hoist placed on the level. The end shaft compartment was used by the bucket while the skip was brought down below the bucket in the next compartment and the bucket dumped into it. The hoist had two drums, the first of which carried the hoisting cable, while the second carried a cable for the bucket trolley to run on. A hole was always drilled near the shaft bottom, in which an eyebolt was placed to which was tied one end of the running cable. When the first half of the shaft had been entirely completed, work was started on the second half, which was stoped down into the first half. Anywhere from 9 to 12 holes were used on the second half and the cost was only about $12 per ft. No time was lost in mucking on the second half. As soon as drilling was finished, the holes were blasted, and after a very small amount of cleaning and scaling the machines could be set up again and mucking started on the bottom of the first half.

In contrast to this method of using the bucket was that used in a shaft inclined at 47°, which was sunk by the same company at another mine. Here small air hoists were also used to hoist the buckets, which ran on skids, two buckets being used, each having its own hoist and using the two end compartments of the shaft. The hoist-cable pulley, as well as the dump, was on the foot wall of the shaft instead of on the hanging wall as in the previous case. The bucket was automatically dumped over a pocket in the foot wall, and the muck was drawn

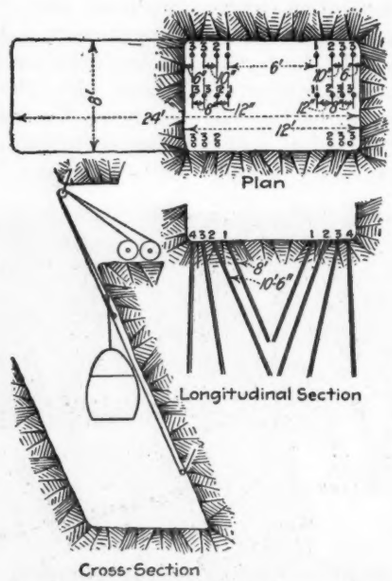


FIG. 1. DRILL ROUND USED IN SINKING CREAN HILL SHAFT

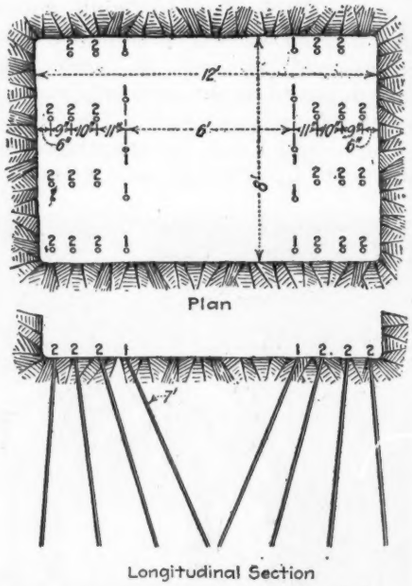


FIG. 2. DRILL ROUND EMPLOYED IN SINKING DOMES INCLINE

*517 West 171st St., New York City.

TABLE SHOWING SUMMARY OF SINKING RECORD,

Year 1915	Advance			Total Time for Sinking Operations							Work			Drilling		Labor in Shifts			
Month	From Depth	To Depth	Month's Advance	Drilling	Blasting	Blowing Smoke	Mucking	Timbering	Setting Up	Delays	Number of Skips	Calc. Develop., Tonnage Hoisted	Rounds Pulled	8-Hr. Machine Shifts	Total Feet Drilled	Drill Runners	Drill Helpers	Muckers	Surface Trammers
August.....	206	332	126	28.3%	13.1%	2.7%	47.2%	3.5%	4.5%	0.7%	3,022	3,590	18	*123.2 = 2,668		513.6	519.0	987.8	359
				Hr. Min.										308.3					
				210-37	97-17	20-20	350-51	26-29	33-11	5-15									
September...	332	478	146	28.2%	7.8%	5.8%	50.0%	2.3%	5.0%	0.9%	3,026	4,161	21	294.0	7,291	476.4	478.8	1,038.9	349
				203-01	56-10	42-08	359-48	16-23	36-11	6-19									
	478	586	108	27.7%	5.9%	4.3%	52.8%	4.4%	3.6%	1.3%	3,049	6,200	15	223.6	5,575	349.9	354.9	917.5	292
October.....	586	642	56	166-44	35-26	25-50	318-08	26-23	21-48	7-51			6	79.1	2,096	121.6	134.3	163.3	71
				41.5%	6.5%	3.1%	37.9%	1.4%	9.1%	0.5%									104†
				58-45	9-10	4-25	53-48	2-00	12-57	0-45	2,512								

*In August total drilling record was not kept but only for 123.2 mach. shift of the 308.3. † In Oct. the 104 trammer was at chute at raise bottom.

off from this pocket via chutes, in a drift run behind the shaft, and thence trammed to the rock pocket on the level, from which it was hoisted by the skip with the other mine rock.

The second method is for a flat inclined shaft at the Dome mine, South Porcupine, Ontario, Canada. The slope of this shaft was about 10°, and it was raised. The size was 12x8 ft. In each round 32 holes were drilled. There were five holes, numbered 1 in Fig. 2, on each side of the cut, while four were sufficient for the rest of the round except for the square-up holes, where it was found that three would do the work. Two machines were used on a bar. About 5 to 6 ft. was pulled in a round, and about 25 ft. advance a week was considered fair. The cut was fired first. As soon as the smoke and gas had cleared, the rest of the round was fired. After the incline had advanced a little, the gas was found to cause considerable delay even with the air blowing as is the custom. A water spray was then tried, setting up the pipe before the blast and afterward turning on the water from a valve placed outside the incline. After the spray had run a few moments, the men entered and pulled it to the face, spraying the face, wall, muck and the sides. While before the use of the water it had been necessary to wait probably an hour before work could be started, after its use the men could return almost immediately. The machinemen did no mucking. A small air hoist was placed at the bottom of the incline, and an extra bar was set a short distance behind the machine bar to which extra bar was attached the pulley by which the cars were pulled up for the trammers to load.

The third method was used at a new shaft being sunk at the Creighton mine, Ontario, Canada. All mucking in this shaft was done by the machinemen directly into skips. A good temporary headframe was erected and an electrically driven two-drum hoist installed that was as good as the permanent hoists at some mines. This shaft was 33x8 ft. and inclined at 55°. The same type of cut as that used at Crean Hill was employed, but the shaft was sunk all in one part. Blasting was done electrically, the cut was fired first and mucked out, after which the rest of the round was fired. Three bars were used on each side of the shaft, carrying two machines each, making 12 machines in the shaft. The rounds pulled ranged all the way from 6 to 10 ft., but averaged about 7 ft. Complete and accurate figures were kept of all operations, and an elaborate daily report was made from which a monthly sheet was prepared. The figures for several months are shown in the accompanying table.

The shaft was sunk in granite most of the way. Considerable time was lost blowing smoke, but when the shaft reached the sixth level, a drift was put in to connect with the old workings, which furnished a strong draft and good ventilation. From the eighth level a drift was driven to the line of the shaft and a raise put up to meet the shaft above. Chutes were constructed at the raise bottom with the idea that muck could be drawn off here after the raise met the shaft and that the machinemen could employ all their time drilling facilitated by stoping the shaft into the raise. The raise proved to be rather small, however, and the muck could not be drawn off quickly enough, so that considerable mucking had to be done. The raise choked up once or twice and had to be blasted down. On the whole it can perhaps be said that the raise hardly justified itself. True, a few additional feet were gained in advance for the month, but since the rock drawn off from the chutes below had to be taken up through the ore shaft and the ore hoisting suspended from time to time, the output was lowered. No figures are available, as to the cost of raise and shaft. It took about 8 to 10 hr. to drill a complete round and about 24 hr. to muck it out and blast. The table shows the percentages of time consumed on the various operations.

NO. 3 SHAFT, CREIGHTON MINE, CANADIAN COPPER CO.

(8 Hr.) Bosses	Nippers	Hoistmen	Timberman	Drilling: Feet Drilled per Mach. Shift	Ft. Advance per Drill Shift	Ft. Advance per Round	Mucking: Average Skip Capacity	Average Time per Skip	Skips per Hour Mucking	Per Cent. Time Loading	Per Cent. Time Hoisting	Av'ge Tons per Ft. Advance	Tons Mucked per Mucker Shift	Averages Shifts, Labor per Foot Advance: Drillers	Helpers	Muckers	Surface Trammers	Bosses	Nippers	Hoistmen	Timbermen	Bonus, Per Cent.	Remarks
99	89	79	109.6	21.7	0.41	7.0	1.19	7.0	8.4	71.3	28.7	28.5	3.63	4.1	4.1	7.8	2.9	0.8	0.7	0.6	0.87	26	
95	90	90	76.9	24.8	0.50	7.0	1.37	7.1	8.4	72.2	27.8	28.5	4.01	3.3	3.3	7.1	2.4	0.7	0.6	0.6	0.52	46	
81	75	75	97.6	24.9	0.48	7.2	1.37	6.3	9.5	67.8	32.2	37.8	5.74	3.2	3.3	8.5	2.7	0.8	0.8	0.8	0.90	30	Top row of figures applies before the shaft reached raise No. 32 and bottom row after shaft reached the raise
20	18	18	12.0	26.5	0.71	9.3								2.2	2.4	2.9	3.1	0.4	0.3	0.3	0.21		

Jackhamers at the Pozo Mine

By Emmet F. Galligan*

The writer has recently had the unusual experience of encountering a sulphide ore so extremely hard that it could not profitably be mined with stoping machines. It was nearly impossible to drill holes deeper than 3 ft., as the drill bits would heat to such an extent in a short time that they would batter and it would be impossible to get another steel to follow.

After experimenting for several weeks with different kinds of steel, it was decided to discontinue back-stoping and try mining underhand with jackhamers. It was an easy matter to handle the muck, as there was a ventilating raise through the block at the end of the ore shoot; so two jackhamers were started benching, taking the cuts from the raise. At first not much headway was made, as the benches had to be started in such shape that the ore would run into the raise without any great amount of mucking. As previously found in work with the buzzers, the drill bits of the jackhamers would heat in the dry holes and there was no available water closer than the second level below. Therefore a pipe line was laid to the water supply and a 500-gal. tank installed with air connections, so that the water could be forced through the pipe to the machines. Each jackhamer was

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then equipped with a water hose, clamping it to the machine just above the steel holder, and on the end of this hose a nozzle valve was used so that the machineman could regulate the water to clear the hole but not use an excess. At this point the grief was ended, as the water cooled the drill bits and it was found possible to drill holes to any desired depth. The tonnage broken per jackhamer was greater than it had been possible to break with three buzzers in the backstope.

Sag and Slope Diagrams for the Steel Tape

The high degree of precision easily attainable in ordinary surveying and engineering measurements with the steel tape is often not realized, because of insufficient attention to the sag and slope errors. Help in dealing with these errors is furnished by two diagrams prepared by W. H. Rayner, of the University of Illinois, who discussed them recently in a general paper on taping errors, before the Illinois Society of Engineers and Surveyors.

The sag correction is read from the diagram, Fig. 1, which is for a 100-ft. tape. The curves relate to different pulls and give the corrections for any weight of tape. Thus, for a tape weighing 1½ lb. the sag correction for 14-lb. pull is 0.04 ft. Ordinary 100-ft. steel tapes weigh from 1¼ to 2 lb. Mr. Rayner believes that the average pull is lower than commonly supposed; in standardizing steel tapes 12 lb. is often used.

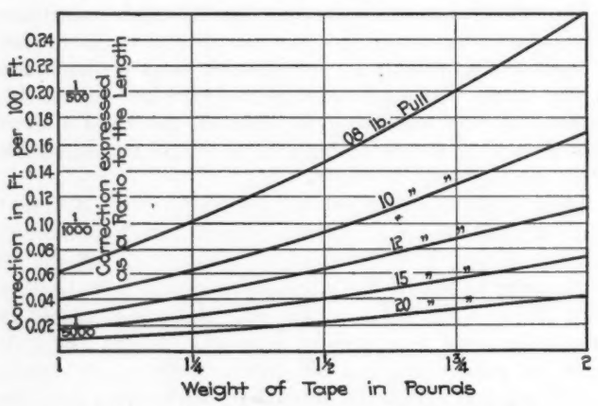


FIG. 1. DIAGRAM OF SAG CORRECTION

The slope correction is given by Fig. 2 to the same vertical scale as in Fig. 1. Like the sag correction it is subtractive; that is, the measured distance is greater than the true horizontal distance. Comparing slope and sag corrections, it appears that a 1¾-lb. tape under 12-lb. pull has the same sag correction when held free horizontally as its slope correction when continuously supported on a 4½% slope. This means that (when no corrections are applied in taping) it is probably better on slopes less than 5% to make measurements with the tape lying along the slope (continuously supported), since the error thus introduced is no larger than the sag correction with the tape freely held horizontal. At the same time the precision is improved by eliminating the uncertainties of plumbing down which is such a difficult operation for the average man.

Temperature effect was also mentioned by Mr. Rayner as important. The difference in tape temperatures between summer and winter measurements may amount to as much as 100° F., sufficient to cause a discrepancy of 3.4 ft. in a mile or, in land measurement, 0.86 acre in a section.

New Du Pont Nonfreezing Explosive

A new line of explosives, bearing the trade name "Arctic" and claimed to be truly nonfreezing under the most severe winter conditions, is being made by the E. I. du Pont de Nemours Powder Co., Wilmington, Del. While water-resisting, these explosives are not recommended for subaqueous work. "Arctic" powders contain no nitroglycerin and are therefore materially cheaper than straight or extra grades. Their velocity of detonation is reported to be even quicker than that of straight dynamites. They can be used in driving tunnels, shafts or other close work, as the fumes given off on detonation are not obnoxious and will not cause headache. All standard-size cartridges are available; if necessary, they can be packed in bulk in paper bags, which are in turn inclosed in wooden cases. To detonate them properly nothing less in strength than a No. 6 detonator should be used. There are five different strengths, which on a weight-for-weight basis are as follows: No. 3, equivalent in strength to a 60% dynamite; No. 4, to a 45%; No. 5, to a 40%; No. 6, to a 30%; No. 7, to a 25%.

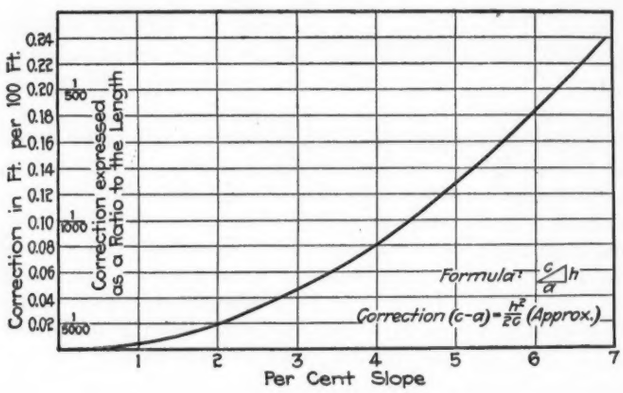

Correction in Ft. per 100 Ft.
Correction expressed as a Ratio to the Length
Formula: c/a h
Correction (c-a) = h²/2c (Approx.)
Per Cent Slope

FIG. 2. DIAGRAM OF SLOPE CORRECTION

Electric Thaw Point

An electrically heated thawing point has been patented in this country by John Robert Quain, of 17 Victoria St., London, S. W., England, Mar. 7, 1916, No. 1,174,444.

This thawing point consists of a tube with its lower extremity sharpened or pointed, to be driven into the ground. Within this tube is an electric resistance, so that the heat generated by the passage of the current through the resistance is conducted to the outer surface of the tube, and the heater being introduced into a hole in the ground that is to be prepared for working, or being forced into position, the heat generated is transmitted to the adjacent ground and thawing results.

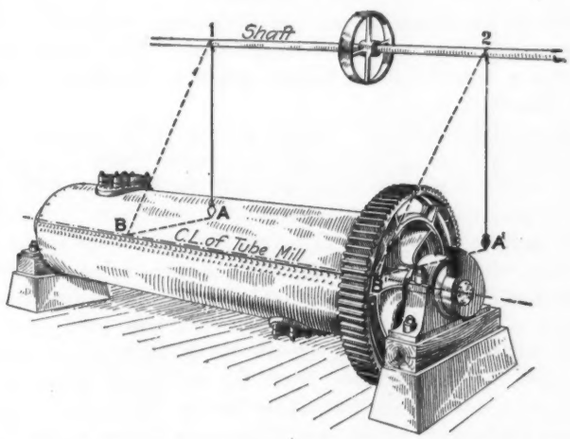
Details of Milling and Smelting

Installation of Tube Mills

By Charles Labbe*

In speaking of tube mills I prefer to distinguish between the small ones, conical or cylindrical, supported on two bearings, or trunnions, and the large ones, which run entirely on tires, or the medium sizes where most of the weight rests on a single tire, the other running in a trunnion. Those of the small sizes require the care given only to heavy machinery supported on two bearings. This is advantageously simple, but the large tube mill, 20 to 24 ft. long, could not be very well supported on two bearings; a weight of 20 to 40 tons resting only on both ends would require such reinforced construction that the manufacturers have not done it to any extent.

As the tires and rollers are placed 12 to 16 ft. apart, the foundation is of prime importance. If the concrete



LAYING OFF CENTER LINE OF THE TUBE MILL

base that supports one set of rollers is independent of the other, it is likely to be the cause of future trouble. Experience has proved that the foundation must form a solid block extending from one end of the tube mill to the other, regardless of the depth. If concrete is used, it must be the very best under each set of rollers, but can be made poorer to fill in between and around the pillars. Reinforcement, although not absolutely necessary, is recommended. If the rollers were set on independent pillars, masonry or concrete, nothing would prevent them from spreading or moving to one side or the other and putting everything out of line. The same would happen if any chance was given the pillars to settle. Even vibrations of near-by machinery have caused well-set independent pillars to move sufficiently to give trouble, and the space in between had to be filled and reinforced.

The center line of the foundation-bolt templet, being also the center line of the tube mill, must be lined up with the mainshaft, because once in place, nothing can be moved. If the shaft is overhead, two plumb-bobs are lowered from the same side of the shaft to points A and A' on the mill floor, Fig. 1. Lay the same distance AB and $A'B'$ square to AA', the center line of tube mill. To check points two lines are fastened on the shaft, one on one side of the plumb lines at 1 and 2, the other end at B and B', both lines perfectly square with the shaft. Measure the distance $1B$ and $2B'$ which must be the same; also 1, 2 and BB' must be equal. If you have a transit handy, using the two plumb-bobs to get A and A', the job is very simple. If the main shaft rests on the mill floor, to have the center line of tube mill parallel with the shaft, simply takes equal distances from the shaft to both ends of the line on the templet squarely with the shaft.

In finishing the foundation of the upper part of the block on which the roller castings will be set, be sure to make it perfectly level and use a rich mixture of concrete. When the casting is put in place and the bolts straightened, it should be again made sure that everything is level. It often happens that the cast-iron base has a limited area bearing on the concrete. In such cases it is advisable to place between the casting and the concrete a sheet of iron ½ in. thick, extending beyond the base and, better yet, under this extended base to place a sheet of rubber ¼ in. thick; because if the area of contact is not thus extended, the casting may "eat" or grind into the concrete, especially in that portion close to the driving gear, where the vibrations are at a maximum.

To unload a tube mill from a wagon or car, two long 12x12-in. timbers may be placed under the tube supported on cribbing made of 6x6-in. tubes 12 to 18 in. apart and a chain block at each end to control the descent. Unless you can unload on a very even floor, large timbers will have to be laid for a track, placed parallel and 4 to 6 ft. apart, according to the size of the tube mill. Iron pipes or round timbers may be used for rolling the mill, spaced 3 to 4 ft. apart. Bring the tube alongside the foundation and in the meantime put the rollers in their boxes on the opposite side of the mill from which you are working, with the adjusting screws set as far back as possible. Place timbers at right angles to the tube at the wooden rollers, so that with the help of jackscrews it may be pushed up high enough to rest on the tube-mill rollers.

If the tube mill is not already lined, it should be done now, for there will be several days' work adjusting shafting, etc., during which time the cement may set; or if metal lining is used, this naturally takes time to put in place for the first time.

The most important adjustment for a tube mill running on tires is the setting of rollers, because on this being correct depends the wear, upkeep and the smooth running of the mill. On one side of the mill set the four roller-bearing boxes against the shoulder of the casting and tighten the bolts firmly. This side of the mill is not to be touched any more under ordinary circumstances, the rollers on the other side being adjusted to cause the tube to travel one way or the other. To gage accurately the set of the rollers, cut a piece of iron to fit in between them, shape both ends somewhat like a center punch and

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use this gage as you would an inside caliper. The bumper rollers are placed on each side of the tires. They must allow the tire to run ⅛ in. outside of the rollers' edge; not to hold the tube on one side or the other, but simply to limit its travel.

The adjusting screws have square heads, and 1, 2, 3, 4 should be stamped on their faces, so that when one screw is turned the other will be turned the same; otherwise the rollers will wear unevenly. The driving shaft (jackshaft) is installed, lined up with the mainshaft and the gear keyed in place. If a clutch pulley is used on the mill, it had best be placed on this shaft where it is in sight all the time and handy for adjustment or repairs. A pinion gear comes with the mill, but for convenience it is well to have an extra one on hand with a key fitted ready to put on should the original one wear out or break.

Should the tube mill have herringbone gears, allow it very little side play, because the wear would be all on one side and would increase the power required to rotate the mill. At least one manhole must be provided to permit inside inspection without opening either end; an opening of 12x17 in. will be sufficiently large for an ordinary man to crawl through. The lining being in place, the mill may be run empty for several hours to limber the shaft and bearings. If any bearing becomes hot when well lubricated, the remedy will not be salt, sulphur or castor oil, but to find the cause and remove the defect. After a satisfactory empty run, half a load of pebbles is put in the mill and both ends closed.

Calking Joints and Bolt Holes

All bolts, joints and parts subject to leaks should be put together with hemp or cotton wicking dipped in asphaltum. There should not be a single leak in the whole tube mill—do not figure on a leak taking up in the future. This is not a boiler where a package of cornmeal will "fix it all up." Cyanide solutions will work their way where there is the slightest chance, and the leakage increases unless remedied in time. The mill half-loaded with pebbles is run for a couple of hours, and pebbles are added until the full load is in. The engine or motor behaving well, the water is then turned in at the feed box. If any leaks show up, stop and attend to them at once. If there are places that are unhandy to get at or to crawl into about the mill, make the repairs yourself so that later on you can direct new men how to get to them and tell them what tools they need. No feed or solution is given to the tube mill until everything is in perfect running shape; then the ore is fed in proper amounts.

The tube mill having run a day or so, the gears and tires are lubricated with heavy oil. Grease as used in grease cups does not work well; the heavy pressure pushes it to one side and it is thrown off, never being fluid enough to run back and cover the rollers. I have found heavy oil most satisfactory. Should the tube run heavier to one side than the other, the rollers must be adjusted; the tube mill goes toward the rollers that are spread out and away from ones that are pushed together; ¼ or even ⅛ turn of the adjusting screws is often sufficient to keep the tube "floating" in its proper position. After the tube mill has been running steady for "quite a while," it is a good idea to open the manhole and go inside to see how the lining is wearing on the sides and ends. Always keep extra lining on hand, and when worn thin, take no chances but replace the worn-out parts at once, because the shell will not stand much grinding and repairs to the shell are expensive and take time.

Before shutting the tube mill down, always run most of the feed out. It will leave the inside wet but not muddy, and it will be much easier to start; otherwise the water will run out, leaving a thick pulp which, with the pebbles, forms a compact mass, and when starting this whole mass must be lifted over the center either by hand or by rocking back and forth with the motor or clutch until this heavy part has passed the center and has become broken up. The man starting a tube mill should never throw in the clutch too roughly or he may expect to burn it out, throw the belt off or burn out the fuses or the motor; for the starting power required is several times the power necessary to keep the mill going. Remember this and act carefully.

Chrome-Ore Tapping Blocks for Blast-Furnace Settlers

By B. Magnus*

At Mount Morgan, Queensland, after many years of experimenting with different material for tapping blocks, it was found that more satisfactory service could be obtained by using chrome ore than from cast-steel, cast-iron or cast-copper water-cooled blocks. The chrome ore, however, must be of the highest grade, as ordinary chrome ore is a failure.

By using a block of chrome ore about 18-in. cube and drilling a 1-in. hole through the center with a miner's rock drill, it was possible not only to do away with all water around the tapping breasts of the forehearths, but also to have no occasion to renew the breasts for weeks at a time, whereas the most successful water-cooled cast-iron breast seldom lasted a month when running on low-grade matte. The chrome-ore block was found to work equally well with the high-grade matte from the concentration furnace. Entirely aside from the saving in water and first cost, the continuous operation of the furnaces was much prolonged. The danger from explosion is likewise eliminated.

Treating Impure Bismuth

The method is due to W. C. Smith, assignor to United States Metals Refining Co., Chrome, N. J. U. S. Pat. 1,166,721, Jan. 4, 1916, and is noted in *Journ Soc. Chem. Ind.*, Feb. 29, 1916.

Impure molten bismuth is treated with the following reagents in succession and skimmed after each operation: Sulphur, to remove the greater part of the arsenic, antimony and copper; sodium hydroxide, to remove tellurium and the remaining arsenic, antimony and sulphur; zinc, to remove gold, silver and the remaining copper; and sodium hydroxide, to eliminate zinc. The refined metal is finally purified from lead by crystallization.

At the Mill of the Yellow Pine Mining Co., Goodsprings, Nev., during 1915, the mill head averaged 10.2% lead, 31.8% zinc and 5.4 oz. silver per ton. This made 1,521 tons of lead concentrate, which averaged 53.2% lead, 13.75% zinc and 281 oz. silver per ton; 11,260 tons of zinc concentrate, which averaged 4.4% lead, 33.2% zinc, 2.5 oz. silver; and 2,173 tons of slime, which averaged 7.3% lead, 35.1% zinc and 4 oz. silver. There were 833 tons of waste sorted out on the belt conveyor.

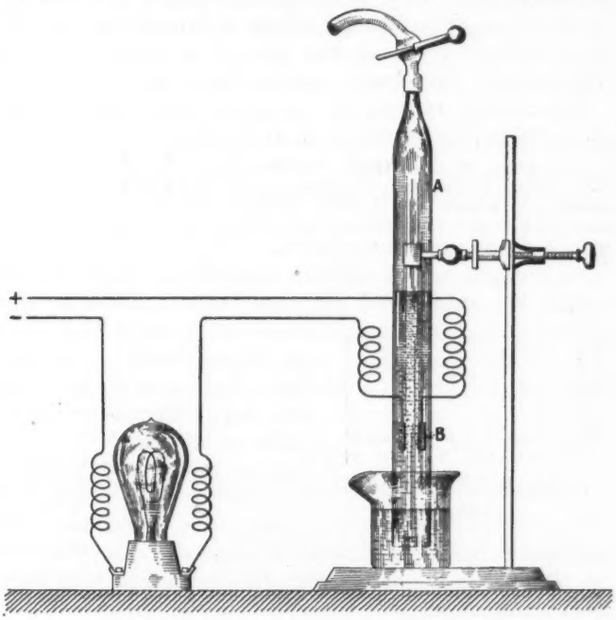
*Consulting engineer, 61 Broadway, New York.

The Assayer and Chemist

Analysis of Fuel Gas

By R. L. Hallett*

The analysis of fuel and illuminating gas is a problem which the chemist and engineer encounter frequently because of the rapid strides that have been made in the development of natural-gas fields, in the improvement of gas producers and in their use in industrial plants. There are many occasions when it is necessary to analyze samples of gas containing small amounts of hydrogen and methane. When I started this investigation I found that the textbooks contained many conflicting directions regarding the proper amount of combustible gas that



A SCHEME FOR FUEL-GAS ANALYSIS

should be present in the gas mixture in the Hempel explosion pipette, to give a complete combustion without the oxidation of any of the nitrogen. To insure accurate results, it was thought best to establish carefully the limits between which the combustible constituents of the gas should be present. This paper will be devoted to a summary of the results obtained and a brief description of a satisfactory method of operation to be used in the analysis of gases.

The Gas Analysis Apparatus

The constituents determined in the gas were the ones ordinarily considered in fuel-gas analysis—carbon dioxide, illuminants, oxygen, carbon monoxide, methane, hydrogen and nitrogen. The apparatus used was the regular form of Hempel burette with a set of absorption pipettes, single and double, and an explosion pipette. The burette was filled with distilled water saturated with carbon dioxide, and the explosion pipette and leveling bottle were filled with mercury. Dry cells and an induction coil capable of giving a quarter-inch spark were used with the explosion pipette.

The analysis was carried out in the usual way, carbon dioxide being determined first by absorption in potassium hydrate contained in a double pipette. Illuminants were next absorbed in fuming sulphuric acid contained in one side of a double pipette, the other side of which was filled with sulphuric acid having a specific gravity of 1.84. From the sulphuric acid the gas was again passed into potassium hydrate to remove any sulphurous acid that might have been formed and also any sulphuric-acid vapor. Oxygen was then determined by passing the gas into a single pipette containing sticks of phosphorus, and finally carbon monoxide was determined by absorption in acid cuprous chloride contained in a double pipette.

The gas remaining after the absorption of carbon monoxide consisted of methane, hydrogen and nitrogen. Sufficient air was added to give the oxygen needed for the combustion of the methane and hydrogen, and the mixture was passed into the explosion pipette, where it was ignited with a spark from the induction coil. A heavy plate-glass screen was placed in front of the pipette before the mixture was exploded. The contraction was measured and the remaining gas was then passed into potassium hydrate to absorb the carbon dioxide resulting from the combustion of the methane.

One volume of methane combines with two volumes of oxygen to form one volume of carbon dioxide and two volumes of steam according to the equation:

$$CH_4 + O_2 + O_2 = CO_2 + H_2O + H_2O$$

The steam immediately condenses to water, and the carbon dioxide formed is equal in volume to the original methane.

Two volumes of hydrogen combine with one volume of oxygen according to the following equation:

$$H_2 + H_2 + O_2 = H_2O + H_2O$$

The contraction after explosion due to methane is twice the volume of the original methane, and the contraction due to hydrogen is one and one-half times the volume of the original hydrogen, from which the amount of hydrogen present in the original sample may be calculated.

When this work was started, the following problems came up for consideration: First, for how long a time should sparking be continued in the explosion pipette to give complete combustion, and would excessive sparking cause oxidation of nitrogen? Second, how large a percentage of combustible gases should be present to insure complete combustion and what was the maximum percentage of combustible allowable and beyond which oxidation of nitrogen would begin to take place?

The effect of sparking was determined by measuring 100 c.c. of air in the burette, transferring it to the explosion pipette, passing a spark through it for varying lengths of time and again measuring it in the burette. Up to 30 sec. sparking gave no contraction, but when

*Chemist, National Lead Co., 129 York St., Brooklyn, N. Y.

continued longer there was an average contraction of 0.28 c.c. for each minute of sparking. It was therefore decided that it is safe to spark up to 30 sec. but no longer. It was afterward found that when the combustible gases are present in the proper proportion, an instantaneous spark causes complete combustion, and even if the amount of combustible gases present is not sufficient for complete combustion, an instantaneous spark will cause the combustion of all that can be burned and continued sparking will have no further effect.

In determining the percentage of combustible gases required for complete combustion, the theoretical mixture of oxygen and hydrogen was used. This mixture was made by electrolyzing distilled water slightly acidified with sulphuric acid, in an apparatus that I designed, shown in Fig. 1.

A glass tube *A* 1 in. in diameter contains two platinum leaves *B*, which are fastened to platinum wires fused through the sides of the tube and connected to the terminals of a direct-current circuit. A one-lamp resistance is placed in series in the circuit. The upper part of the tube *A* is about 8 in. long above the platinum leaves and acts as a reservoir from which the mixture of oxygen and hydrogen may be drawn. The top of the tube is constricted so that a piece of $\frac{3}{16}$-in. rubber tube fits tightly over it. The rubber tube is closed with a screw clamp, and virtually forms a regular Hempel connection which may easily be attached to the burette when some of the oxygen-hydrogen mixture is required.

Combination of Combustible Gases

The proper percentage of combustible gases which should be present to insure complete combustion and not oxidize nitrogen was determined by taking different amounts of the electrolytic mixture of oxygen and hydrogen, diluting with air to a volume of 100 c.c. and igniting in the explosion pipette. It was found that the sum of the combustible gases and the oxygen theoretically needed to oxidize them should be between 30% and 40% of the whole. The most satisfactory mixture was found to be from 33% to 35%. If less than 30% was present, the combustion was incomplete; if more than 40% was present, some of the nitrogen was oxidized and the contraction was greater than the oxygen and hydrogen originally taken. To insure complete combustion, oxygen should be present to the extent of about 25% more than the theoretical amount.

An appreciable explosion occurs when less than the proper amount of combustible gases is present, but the combustion will be found to be incomplete. Proper combustion is accompanied by a vivid flash.

The calorific power per cubic foot for methane is 1,065 B.t.u., and for hydrogen is 345 B.t.u. Two volumes of methane require four volumes of oxygen and two volumes of hydrogen one volume of oxygen for combustion, from which it will be seen that when the combustible gas is composed of methane, more heat is generated in the explosion than when it is composed of hydrogen. If therefore any considerable portion of the combustible gases consists of methane, the percentage of combustible gases and oxygen should be nearer 30% than 40%. If 33% be taken as the best mixture and if the mixture be not allowed to vary greatly from that figure, the results will be excellent in all cases, whether the combustible gases consist of hydrogen or methane or a mixture of the two. The proper mixture may easily be made by diluting with air or adding the required amount of the oxygen-hydrogen mixture from the apparatus already described.

When the combustible constituents of a gas are unknown, it is sometimes necessary to run a preliminary analysis to determine thair approximate percentages, so that the proper explosive mixture may be accurately prepared. When hydrogen and methane are determined in this way, burette readings may be made to check within 0.1 c.c., if care is exercised in allowing the burette to drain properly and all connections are carefully made. The details of manipulation of this method may be found in many books on gas analysis and will not be elaborated here.

Platinum Versus Gold Dishes

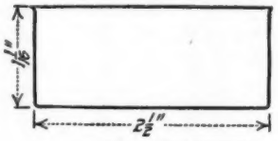
By H. D. Greenwood*

Many of the metallurgical-furnace products sent to the laboratory only for copper contain some of this element in the form of a silicate, which is not decomposed by nitro-hydrochloric acid, but has to be either fused or treated with hydrofluoric and sulphuric acids.

The routine method for copper in nonchilled furnace products in this laboratory is as follows:

One gram of the sample (100-mesh) is weighed out, 5 cc. conc. HNO_3 added and, after the action has ceased, 15 cc. HF added and evaporated to soft dryness; 10 cc. conc. H_2SO_4 is then added and evaporated to fumes of SO_3. Cool, take up with H_2O, and proceed as usual.

As the number of samples received at times far exceeded the number of platinum dishes available, gold dishes were made and tried out. These worked so successfully that more have since been made. In making these dishes a serviceable working dish was aimed at rather than an artistic one. Sixty-five grams of refined gold was cast into a button in a bone-ash-lined scorifier, the bone ash clinging to the bottom was dissolved off in weak acid, the button hammered flat under the trip-hammer, then rolled in the assay rolls to the desired thickness. Disks 3¼ in. in diameter were cut out, taken to a metal spinner and spun to the shape desired.



GOLD EVAPORATING DISH

The cost of spinning was as follows: Making of chuck, $2.65; spinning three dishes, $1.50; cost per dish, $1.38. The cost of the subsequent dishes was reduced to $0.50 per dish, as the previous chuck was used. The gold loss in spinning was 0.33 gram or $0.20 for the three dishes. The weight of the dish is determined by the thickness of the metal desired.

The shape and form found best was 2.5 in. in diameter, $1\frac{1}{16}$ in. tall, with beveled corners and top. The following table gives the loss in weight while in use:

Weight new dishes, grams	57.3940	54.1570	44.7850	156.3360
After 2 months' use, grams	57.2500	54.0720	44.7410	156.0630
Loss, grams	0.1440	0.0850	0.0440	0.2730
After 12 months' use, grams	56.8726	53.6720	42.4523	152.9969
Loss, grams	0.5214	0.4850	2.3327	3.3391

The loss of gold for the three dishes in twelve months' use was 3.3391 grams, or 74c. per dish, which is about one-half the loss in platinum dishes, although the latter are also used for fusions and incinerations.

*Chief chemist, U. S. Metals Refining Co., Chrome, N. J.

Gold dishes can replace platinum dishes for hydrofluoric-acid treatment to an advantage only in works where gold refining is carried on. The gold is on hand, charged out at the regular price and credit given for the scrap returned. The work of melting and rolling is done by the assayer in his spare time, and after a little practice the spinning of them can also be done in an ordinary lathe. Gold dishes, however, cannot be used for fusions or incinerating precipitates on account of the low melting point of gold.

Paper Pulp as Aid to Filtration*

Paper pulp has been found useful for the filtration of ammonium-citrate solution from the digestion of phosphates for the determination of available P_2O_5. It is used as follows: Fit a filter paper (9 cm. S. & S. 595) into 2-in. filter cone. Fill full with paper pulp, and after part of water has run through, press the mass against the sides of the cone extending above the edge of the filter paper. In filtering, the cone may be filled full, as the pulp prevents leaking at top of filter paper. The complete filtration and washing to a volume of 400 c.c. or more is usually complete in 5 min. or less, instead of the half hour or more required without paper pulp, thus materially shortening the time of the operation.

If ashless paper pulp is used, it may replace asbestos for use with Gooch crucibles. After ignition nothing remains but the precipitate, so that ordinary methods of gravimetric analyses are applicable.

To prepare the pulp, make a mixture of one part strong HNO_3 with four parts water in a wide-mouthed bottle. Then add an ordinary filter paper. Shake this vigorously until the mixture is reduced to a fine smooth pulp. Throw the mass on a Büchner funnel, wash free of acid, then mix the pulp with water to form a thin liquid that will pour easily for use.

*P. L. Hibbard, in "Journ. Ind. and Eng. Chem."

Methods of Rapid Analysis

In the article on "Methods of Rapid Analysis," by L. B. Pringle, in the *Journal* of Apr. 8, 1916, p. 650, the loss of a line by the compositor spoiled the meaning of one of the descriptions. In describing preventive solutions, the text should read: ". . . consists of 160 grams manganous sulphate, 1,750 c.c. water, 330 c.c. phosphoric acid and 320 c.c. sulphuric acid." In describing the washing of the lead-sulphate precipitate it may be noted that cold water may be used instead of the alcohol specified.

Toughening Paper Filters

A paper in *Chemical News* (mentioned in *The Engineer,* Feb. 4, 1916), by Dr. Clayton Beadle, on the toughening of filter papers, describes a useful and simple method of strengthening a filter paper to such an extent that it will withstand the pressure produced by a powerful filter pump.

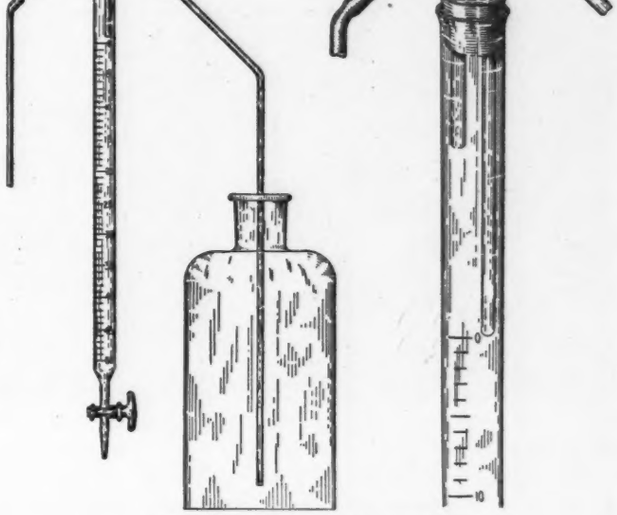
The paper is folded and fitted into a dry funnel in the ordinary way, and then a few drops of nitric acid of 1.42 specific gravity are allowed to fall in the apex of the paper cone. The funnel is canted and quickly rotated so as to saturate the free unsupported apex of the cone with the acid, and is then immediately rinsed out under a tap, being filled and emptied from the top repeatedly, and finally rinsed out with distilled water if the presence of tap water is undesirable.

This treatment does not slow the filtering action of the paper. On the contrary, it tends to accelerate it, though treating the paper similarly all over slows the filtering very considerably, perhaps four or five times. The method is credited to E. J. Bevan, about 30 years ago, but few people seem to know of it.

Burette-Filling Device

By James O. Johnstone*

This device does not expose the chemicals to the action of rubber tubing, no stopcocks are necessary, and the zero mark is reached without extra manipulation. It consists of a siphon of ⅛-in. glass tubing with its lower end in the bottle of standard reagent and the upper end in the burette, terminating a little above the zero mark. This



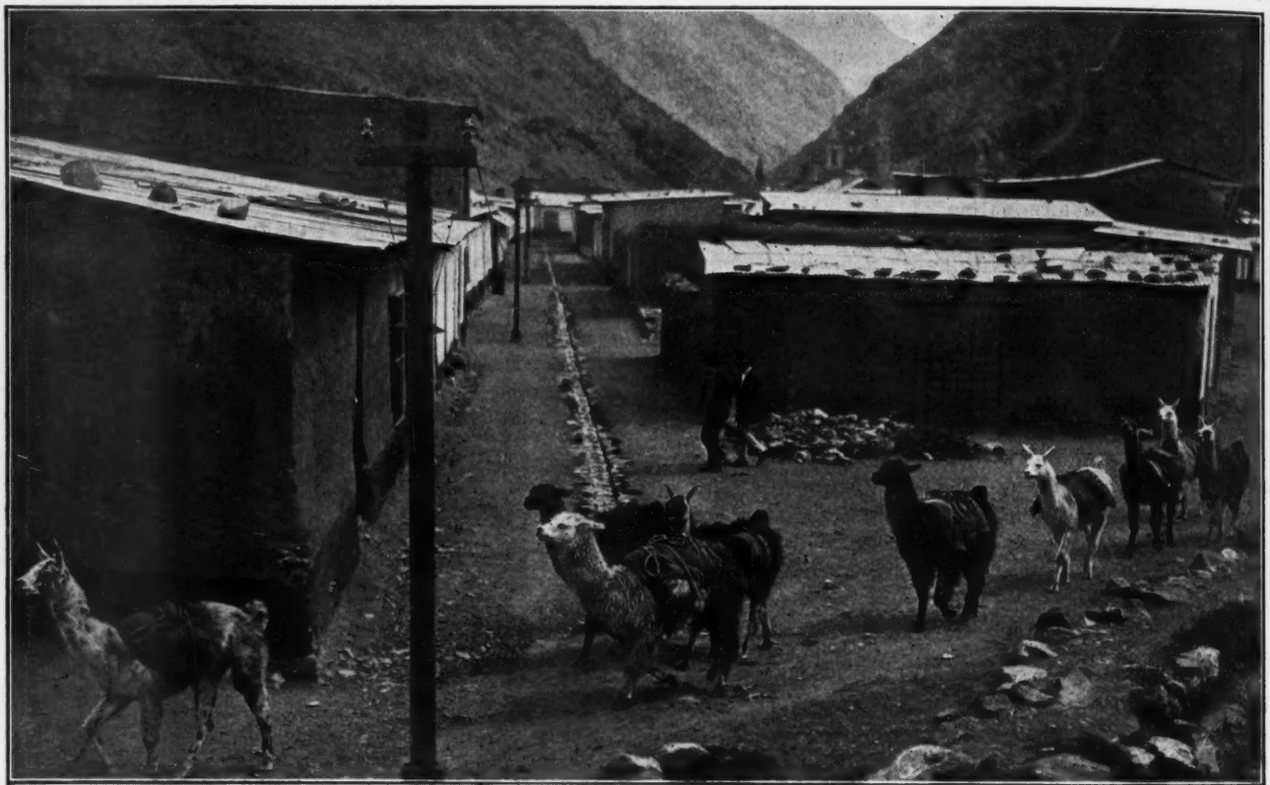
A BURETTE-FILLING DEVICE

end is drawn out to about $\frac{1}{16}$ in., but not smaller. It is held in place with a rubber stopper. Another tube enters the burette through the stopper; but terminates just inside and is connected outside with about 18 in. of rubber tubing. To fill the burette, the operator sucks through the rubber tubing till the reagent fills the burette above the zero mark. When he releases the suction, the excess reagent is siphoned back into the bottle. It is important that the upper end of the siphon should not touch the sides of the burette. The suction may be obtained by means of a suction pump using a three-way cock to apply and release the suction.

Silver Is Separated From Univalent Mercury, according to the classic method, by leaching out silver chloride with ammonia from the mixture of mercurous and silver chlorides. N. von Zweigbergk (Zeit. anorg. Allgem. Chem., vol. 93, p. 320) remarks that the test fails if mercurous salts are greatly preponderant, and advises, having settled that mercurous mercury is present, that it should be oxidized to mercuric with sodium hypo-chlorite and nitric acid, in case no confirmatory test for silver is obtained. That is, the absence of very small amounts of silver cannot be affirmed if large amounts of mercurous salts are present simply because the ordinary test for silver fails and the modification of the test should be used.

*Chemist, International Lead Refining Co., East Chicago, Ind.

Photographs from the Field



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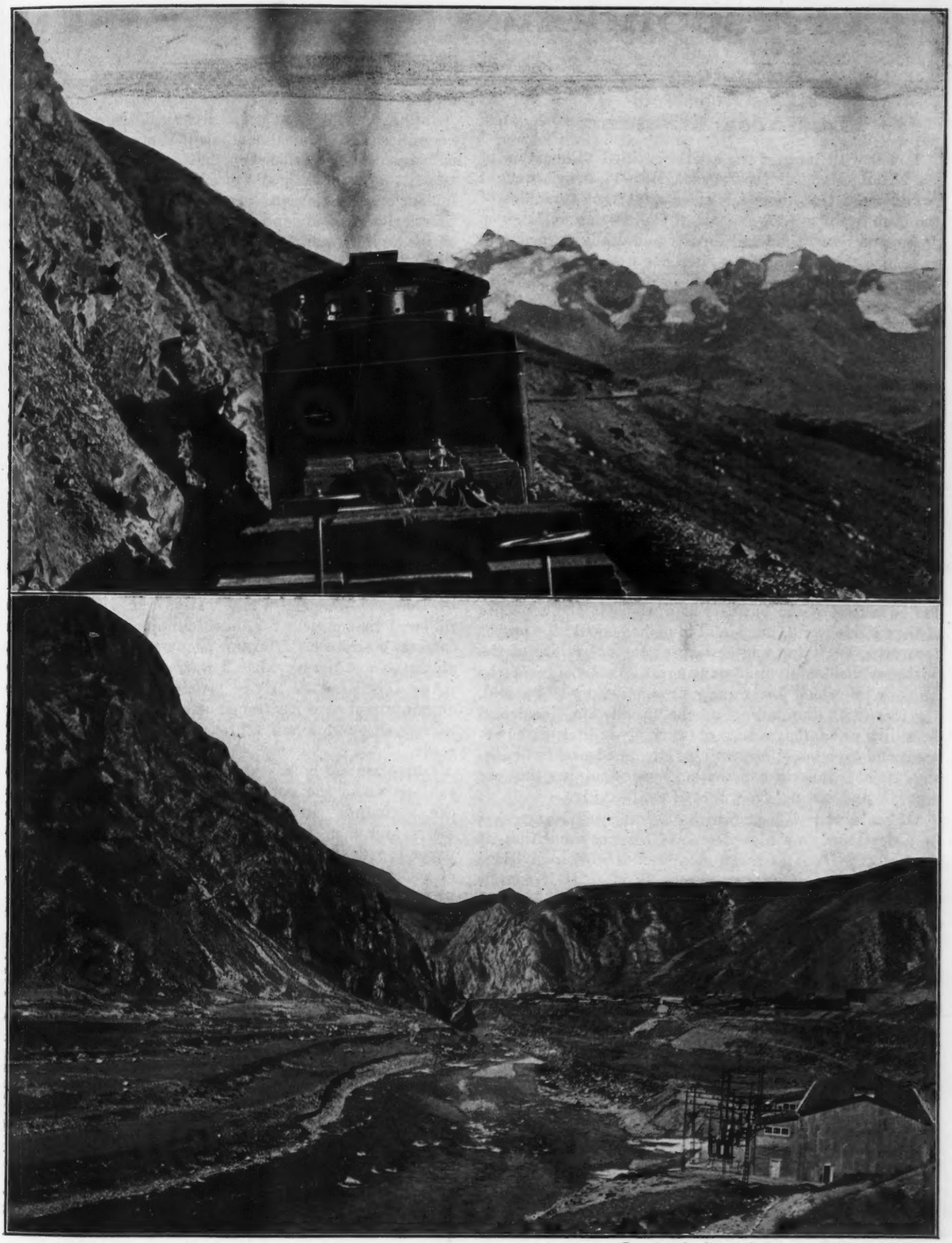
MINING MEANS AND ADJUNCTS IN THE SOUTH AMERICAN COUNTRY

Upper view shows a pack train of llamas in a typical Bolivian mining village. Note the simple method of keeping the corrugated-iron roofs on the buildings. The lower view shows the Casapalca copper smeltery, Peru, working at an altitude of 14,000 ft.



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MINING MEANS AND ADJUNCTS IN THE SOUTH AMERICAN COUNTRY

The upper view is of a copper-laden train from Cerro de Pasco smeltery in the Cordilleras. The lower view shows the hydro-electric generating station of the Cerro de Pasco company

Correspondence and Discussion

Business Efficiency

I read with interest the article entitled "Education of the Mining Man," in the *Journal*, Mar. 18, which brought out the idea that there are other important functions of the business of mining outside of engineering.

Apparently it is difficult for the technically trained man to realize this fact. The writer has noticed cases where the technically trained engineer, upon assuming the duties incident to one of the departments of production or those of management, considered his duties as less important and more or less subordinate to those of engineering, and would still dwell upon the engineering functions of the business instead of developing the possibilities in his new division of effort.

The technically trained engineer seems to overlook the fact that a knowledge of the markets where the materials and supplies necessary to production may be best secured; their purchase, transportation and storage, which is incidental to purchasing; the employment and application of labor, supplies and power, incidental to production; the supervision, compensation and organization of labor, and the proper balancing of the activities of each department in itself and to the other departments, as well as the adjusting of the business as a whole to the activities of the outside world, incidental to management; the proper recording, analyzing and costing of the operations of the business, incidental to accounting; the knowledge of the markets in which the mine's production must be sold, together with the selling of the production, incidental to selling; and the raising of working capital, disbursement and investment of earnings, etc., incidental to financing, are also functions of the business of mining that are separate and distinct from that of engineering.

Of course it is well known that mining engineering has been developed to a high degree of efficiency and that its field of activity is as broad as any of the other divisions of the business of mining, especially when it is considered to cover the mechanical, electrical, metallurgical and chemical technique of mining operations, as well as the technique of ore development and extraction. Nevertheless, it is only one of the important divisions of the business of mining.

In the development and equipment stage of mining, proper engineering is all-important, and of course the great advance in mechanical and technical efficiency of the present-day production methods of mining, milling, smelting and refining of metals over those of 15 years ago has been due principally to the brains and inventive genius of the trained engineer.

However, in the operation of producing mines, the routine work of the engineering department is far from being of most importance to the economical and profitable operation of the business machine.

There is a great need of business efficiency in present-day mining operations, due no doubt to the great publicity and attention given to the technical and mechanical side of mining. The need in numerous large mining corporations having wonderful technical departments and magnificent mechanical equipment is not for more technical or mechanical efficiency, but for more business efficiency, more intelligent purchasing, better and more human organization and management, more uniform and practical accounting and costing, and a broader knowledge of the world's markets in which the production must be sold.

The awakening interest of mining managers in profit-sharing and bonus systems of compensation, central employment stations and lay-off systems, safety- and personal-efficiency departments, as well as sickness and accident insurance and benefits, etc., evidence the realization of the need of exercising efficiency in the human and business side of mining.

T. O. McGRATH,
Auditor, Shattuck Arizona Copper Co.

Bisbee, Ariz., Mar. 22, 1916.

Filing Technical Literature

In the *Journal* of May 15, 1915, Alvin R. Kenner discussed the subject of indexing and filing, pointed out some of the defects of the Dewey decimal system and presented a substitute classification. I bought a copy of Dewey's "Decimal Classification" in 1892 and have followed that system for filing clippings, pamphlets and catalogs ever since. I became acquainted with the system at the college library when I was a student and adopted it, as I believed the study given to the subject by the author would save me from mistakes that would be hard to remedy, and I am still satisfied with the choice I made.

One essential in any system of filing is to file allied subjects under the same heading every time so that they can be found. It is easy to file things according to a whim and then to forget where they were put. If a paper is put away in a careless manner with no thought of getting it again, it might about as well be filed in the waste basket.

I have found limitations in the Dewey system and have added subdivisions to subjects in which I have been especially interested, and in others I do not use all the subdivisions that Dewey gives. For example, Dewey gives: "622.67 hoisting engines, ropes, drums." I placed the surface-hoisting plant under this number and have subdivided it by letters which I use as suffixes to the numbers, thus:

622.67 Pl = Plants and systems in general
622.67 H = Hoisting engines, steam, air, gas
622.67 El = Electric hoists
622.67 Wr = Wire ropes, fittings, safety hooks
622.67 Hf = Headframes, chairs
622.67 A = Animal- and man-power hoists
622.67 S = Signals
622.67 T = Mine telephones
622.67 M = Miscellaneous; controllers for hoists, accidents

I interpreted Dewey's "622.68 cages, skips, buckets," to include all underground equipment, so there is considerable of the hoisting plant that is not included under 622.67. The reader may criticize the material that I have included under hoisting plants. For example, wire ropes are a manufacture of iron and steel and might be

put under such manufactures at 672; also, mine telephones might go under 654.6 with other telephones under the head of "communication." I will agree with that criticism when it applies to a general library where information on wire ropes or telephones might be desired by persons who had no connection with mining, but it does not apply to a private file where the owner is interested primarily in mining.

The principle must hold that matter is to be put under the subject to which it is related and that is of most interest to the owner of the file. Dewey emphasizes this principle by numerous remarks in the text of his book; thus, after "532.8 applications, machines," relating to hydrostatics and hydraulics under the heading of "physics," is the note: "Except for libraries making physics much more prominent than useful arts, all the applications will be more useful under their proper heads in useful arts."

The use of letters for additional subdivisions, as I have shown for 622.67, is indicated in the introduction to Dewey's book as giving "all needed freedom to the personal equation" and provides for "peculiar classification in peculiar cases." To me the Dewey system appears to be an excellent one for filing one's personal papers. The fact that it is so largely used in libraries is a strong recommendation for it, as it enables one to use such libraries more easily from his knowledge of their system of classification. If it is found to be too brief on certain lines, it can be expanded by suffixing numbers in the next decimal place or by using letters for suffixes. Neither of these moves the matter from the general class assigned to it by Dewey.

An Extension of the Dewey System

The University of Illinois has published a pamphlet on "An Extension of the Dewey Decimal System of Classification Applied to the Engineering Industries,"[1] which gives elaborate subdivisions of engineering subject, 620, 621, 622, 624, 625 and 628, transportation 656, metallurgy 669 and building 690 and repeats the classification of allied subjects as given by Dewey. It is a complete guide in itself to the filing of technical subjects.

In filing I place clippings and small papers in 7x10-in. stout manila envelopes with one of the long edges open and made without a flap. These are marked with the number and subject of the contents and, while the file was small, were stood on end on a shelf with the opening toward the wall. When the file outgrew this arrangement, I got pasteboard and light wooden filing cases to hold the manila envelopes and loose pamphlets on related subjects, and devoted one filing case to a general subject. The filing cases are 7½x11x2½ in., open on one long edge. The envelopes and pamphlets are slipped in with their backs out, and then the cases are stood on a shelf with the open edges to the back and against the wall, which keeps the contents reasonably clean. These envelopes and filing cases can be bought of the Library Bureau, Boston, Mass., or they may be made at a local paper-box factory. The shelves for filing are spaced 12 in. apart so as to give room to tip up the 11-in. cases in removing them, and sometimes I have had a curtain hung in front.

This equipment is cheap and grows with the quantity of matter that is to be preserved. The size is convenient; it will take most pamphlets and magazines; pages from the engineering papers will go in the envelopes by folding once without trimming; large sheets like maps, blueprints, etc., are folded until they are small enough to go in, the creasing being condoned to facilitate the filing. The only troublesome things I have are pamphlets that are too large for the filing cases and too heavy to be folded, as some catalogs and government reports. These I put on top of the filing cases, in the space below the next shelf.

Mr. Kenner closes his article with a section headed, "Does it pay to file?" and draws the conclusion that it does. He says "yes," while I am almost ready to say "no." If a young engineer should ask me about it I would tell him to go slow in building up a file. Let me illustrate by my own experience. I have taken one continuously and at times have bought or received from others several engineering papers during the 20 or more years covered by my file. I have received the transactions of one engineering society for 15 years, also numerous government reports, trade publications and miscellaneous pamphlets and papers from various sources. I have made clippings from the papers and dissected the transactions and filed these and the pamphlets. The result is that I have a file that is a burden; it has outgrown shelving that occupies one end of my study and extends from the floor to the ceiling. If I move, as I have done and most engineers do, it will be laborious and expensive to pack, transport and reëstablish. So unless an engineer is sure that he is a fixture, he had better avoid the encumbrance of an extensive file.

There is another disadvantage in a personal file. It creates a habit of saving, and one spends time in skimming through the current publications, choosing articles that appear worth saving, trimming and numbering them and then putting them away, instead of reading them carefully and absorbing the information contained. Mr. Kenner suggested in his article that an assistant could do the mechanical work, but until an engineer has advanced considerably in his practice, he will not have an assistant and meanwhile he must keep abreast of the current progress in order to advance.

The Problem of What To File

The problem of how much or how little to file is a hard one. As I write, a post card arrives from the Bureau of Mines offering me any of six pamphlets, 6x9 in. in size with a total of 300 pages, which I can have for the asking. They are all on interesting subjects relating to my business, but they are not applicable to work on hand. They will occupy an inch on the shelves. How many shall I send for?

As a file grows, it requires increasing attention, since as the material under the general heads increases, it must be subdivided and this editing requires more time and knowledge of the subject matter than the first filing. Thus take the heading of "hoisting plants" used as a previous example. In a small file everything relating to the general subject can be put in one receptacle but as the items increase in number they must be subdivided and a separate holder provided for each subdivision. General articles will then begin to be troublesome; they must be dissected by clipping or by abstracting and the parts filed under their respective subheads, or they may be put into one general holder under the main heading.

[1]Bulletin No. 9, revised 1912, Engineering Experiment Station, Urbana, Ill.

The latter method simplifies the filing, but when the subject is to be consulted most of the material relating to it will be found in its own special holder. The general holder will also have to be searched in order to be sure that one has all that is available. Slips of paper in the file with references to articles filed elsewhere are a help in finding things, but add to the first labor of filing.

There are engineers whose work necessitates their keeping a file, but I believe the cases are limited to men who are conducting experiments or investigations as a business or a hobby, are teaching or are preparing technical literature, and then the file should be limited to the subjects involved and after its contents have been digested and abstracted the superfluous matter should be discarded. With a young engineer or a man engaged in engineering along any broad line, it is better to read and digest the current engineering literature that comes to him, making brief abstracts of his reading with choice clippings added, so that in time he develops a compact treatise based on his own study. Notices and reviews of new books and memorandums of pamphlets that can be bought should be entered as a guide to sources of additional information. If the notes are made in a loose-leaf notebook, they can be arranged by subjects.

This abstracting will take time, but by limiting the amount of literature coming in to what one can digest, the result will increase one's knowledge and will give a compendium of current information that will be a valuable supplement to a few well-chosen books and keep the library in a portable form. The gain in available information will be worth more than the possession of a cumbersome file in some distant study. My object in writing is to point out, especially to young men, the importance of keeping posted on current engineering practice, but to avoid the error of accumulating an unwieldy file of things he may want some day.

EDWARD B. DURHAM.

2227 Ward St., Berkeley, Calif.

Vanadium in Michigan

I have before me Bulletin No. 18, Mineral Technology Series No. 9, Arizona State Bureau of Mines. The title of this bulletin is "Vanadium"; its author is P. E. Joseph.

Under the heading "Vanadium in the United States," on page 8, appears a paragraph describing a supposed or reported occurrence of vanadium ore in Michigan. The following is the paragraph:

> Michigan: Here vanadium ore was discovered in Baraga County, 7 mi. north of Skanee and 30 mi. from L'Anse, the nearest railroad station. This ore is endlichite. The orebody is a fissure vein and at a depth of 12 to 13 ft. is 24 in. in width and seemingly increases as the depth of the shaft increases. The orebody is soluble silicate which contains 21.5% of vanadium and traces of uranium, calcium and magnesium carbonate and iron in varying amounts.

In the third line of this paragraph we are informed that the ore is endlichite, but in the last sentence the author states that the orebody is soluble silicate containing 21.5% of vanadium and traces of uranium. Evidently the author is reprehensibly careless or is simply ignorant of the mineralogy of vanadium minerals. But after all, he seems merely to have condensed in this absurd paragraph the essentials of an article by George W. McGhee.

The reported discovery of valuable vanadium ores in Michigan created considerable interest at the time, and I took the trouble to have Prof. W. E. Hopper, of this department and the Michigan College of Mines, make an investigation. Subsequent to Professor Hopper's report vein materials were examined mineralogically and chemically by him and by Prof. A. E. Seaman and no vanadium or uranium minerals were found. I hope that you will find space in the *Journal* to dispose of this reported vanadium discovery. R. C. ALLEN,

Director, Geological and Biological Survey.

Lansing, Mich., Apr. 13, 1916.

Record Tonnage Hoisted

In the *Journal* of Jan. 1, 1916, M. R. Percy asks for the record tonnage hoisted through two compartments of a shaft.

I do not know of any better record than that of the Crown Mines here in May, 1914, 26 working days, when 16,530 skips, each carrying 8 tons, a total of 132,240 tons, were hoisted from a depth of 2,400 ft. As far as I know, this work constitutes a world's record.

C. M. RASMUSSEN.

Crown Mines, Johannesburg, South Africa,
Feb. 24, 1916.

NEW PATENTS

United States patent specifications listed below may be obtained from "The Engineering and Mining Journal" at 25c. each. British patents are supplied at 40c. each.

AGITATING AND SETTLING TANK. John E. Rothwell, Butte, Mont., assignor to Colorado Iron Works Co., Denver, Colo. (U. S. No. 1,179,658; Apr. 18, 1916.)

BLAST FURNACES—Charging Bell for Blast Furnaces. Julian Kennedy, Pittsburgh, Penn. (U. S. No. 1,178,522; Apr. 11, 1916.)

CLASSIFIER—Ore Classifier. William W. Guest, Alameda, Calif., assignor to The Ecla Mining Corporation. (U. S. No. 1,178,640; Apr. 11, 1916.)

CONCENTRATOR—Ore Concentrator. Charles E. Thompson and Hans Nelson, Denver, Colo., assignors to The Mine and Smelter Supply Co., New York, N. Y. (U. S. No. 1,180,210; Apr. 18, 1916.)

DISTILLATION FURNACE—Furnace for the Distillation of Metals. Robert H. Engle, Trenton, N. J. (U. S. No. 1,180,118; Apr. 18, 1916.)

DRILL—Rock Drill. Daniel S. Waugh, Denver, Colo., assignor, by mesne assignments, to The Denver Rock Drill Manufacturing Co., Denver, Colo. (U. S. No. 1,178,892; Apr. 11, 1916.)

DRILLING—Core Barrel for Drilling Machines. Joseph M. Gibeau, Mesaba, Minn. (U. S. No. 1,179,173; Apr. 11, 1916.)

HYDROMETALLURGY—Process of Extracting Metals from Their Ores. William E. Greenawalt, Denver, Colo. (U. S. No. 1,179,522; Apr. 18, 1916.)

MINE CAGES—Safety Catch for Mining Cages. John T. Pero and Llewellyn P. Jones, Parsons, Penn. (U. S. No. 1,178,942; Apr. 11, 1916.)

ORE TREATMENT—Apparatus for Treating Ores. Edward R. Holden, Los Angeles, Calif. (U. S. No. 1,179,313; Apr. 11, 1916.)

SCREEN. Edgar B. Hayes, Park City, Utah. (U. S. No. 1,179,428; Apr. 18, 1916.)

SEPARATOR—Ore Separator. Ivan E. Nelson, Santa Clara, Calif. (U. S. No. 1,179,744; Apr. 18, 1916.)

SETTLER AND CLASSIFIER—Combined Settler and Hydraulic Classifier. Courtenay De Kalb, Tucson, Ariz. (U. S. No. 1,177,849; Apr. 4, 1916.)

SINTERING MACHINE. John F. Austin, Monterey, Mexico, assignor to The American Smelting and Refining Co., New York, N. Y. (U. S. No. 1,179,390; Apr. 18, 1916.)

TITANIUM TETRACHLORIDE—Method and Means for Producing Titanium Tetrachloride, ($TiCl_4$.) Louis E. Barton, Niagara Falls, N. Y., assignor to The Titanium Alloy Manufacturing Co., New York, N. Y. (U. S. No. 1,179,394; Apr. 18, 1916.)

WASHING—Table for Ore and Coal Washing. Charles E. Thompson, Denver, Colo., assignor to The Mine and Smelter Supply Co., Denver, Colo. (U. S. No. 1,180,209; Apr. 18, 1916.)

ZINC—Clean-Out Apparatus for Zinc Furnaces. Frank A. Hinkey, Springfield, Ill. (U. S. No. 1,178,518; Apr. 11, 1916.)

Reform of the Mining Laws

At a meeting of the New York Section of the Mining and Metallurgical Society of America, at the Engineers Club, New York, Apr. 19, a constructive program for the amendment of the present mining laws of the United States was considered. The meeting was well attended. The subjoined memorandum was introduced:

The following is an outline of the main provisions regarded as necessary for the improvement of the United States mineral-land law. It is intended to give, not the precise legal phraseology to be used, but the objects to be secured; and it is understood that in the proposed legislation all existing or vested rights shall be recognized and also that all provisions of the present United States statutes and department regulations not conflicting with the new statute shall remain in full force, unaffected thereby. This includes Section 2,319 of the Revised Statutes, declaring all valuable mineral deposits in lands belonging to the United States to be free and open to exploration and purchase, and the lands in which they are found to occupation and purchase, etc.

The new legislation proposed is to secure the following principal changes:

I. The survey of the public lands to be completed as soon as possible and all surveyed lands to be classified as mineral or nonmineral according to the meaning of these terms now established by the United States statute or judicial decisions; such classification, officially announced, to be final until subsequently changed by the Government, and no such subsequent change to affect the rights of location under the former classification. Lands thus designated as mineral to be open to the location of mineral claims only and lands designated as nonmineral not to be open to the location of mineral claims.

II. Mineral claims hereafter located to be 660 ft. square—that is, 10 acres in size and square in form—with boundaries running N and S and E and W. Such claims, when located on surveyed land, shall be subdivisions of the surveyed sections.

Note—This area is about the same as that of the 300x1,500-ft. claims of Colorado. The location would be, of course, subject to all prior rights, surface or underground; and in many districts, claims already located may leave only remnants of area not suitable in size or shape for separate locations. In such cases the practice now authorized by the Supreme Court, of establishing "imaginary boundaries"—that is, of claiming the full area of a claim and then disclaiming the parts of that area already occupied—would be followed. If such a location has no extralateral rights, it will cause no special trouble. The purpose of this provision is, so far as existing rights do not prevent, to make mineral claims as easy to define as agricultural ones.

III. Any number of claims to be located by one person or association; and upon lands already surveyed and officially classified as mineral, the actual discovery of a valuable deposit not to be necessary to a valid location. Existing regulations concerning the marking, notice and record of location to be continued, with the additional requirement that within one year after the date of location record thereof shall be made in the United States Land Office of the land district.

IV. The present requirement of $100 annual work upon each claim, to be amended by providing that $100 per claim may be paid annually into the United States Land Office in lieu of the performance of such work. A person or association holding a group of contiguous claims to be permitted to do the assessment work upon one claim and thereby hold the group, but such work to be of amount equivalent to $100 for each claim of the group. If any person or association perform assessment work in any one year to the value of $100, or more, in excess of what is required to be done in any one year, the excess may be applied to succeeding years, provided, however, that no fractions of $100 shall be considered for this purpose. Proceedings for patent to remain as now.

V. Subject to the existing extralateral rights of mining claimants or patentees, the holder or patentee of a mining claim located hereafter to have the exclusive right of possession and enjoyment of the surface held by him and of the minerals under it, bounded by vertical planes passing through surface boundaries of said land, but not the right to follow any mineral deposit beyond said planes. And the holders or patentees of claims heretofore located to have similar exclusive possession of all the mineral in claims not covered by any existing extralateral rights.

VI. Notice of location of all mining claims, made after the date of the passage of this Act must be filed for record with the register and receiver of the land district within which the lands are situated within one year from the date of each location, and unless final entry and payment be made for such claims within seven years after date of location, exclusive of the time covered by pending adverse claims, all rights thereunder shall cease.

During a prolonged discussion of the foregoing memorandum, it was voted to rewrite the last sentence of Article 1 as follows:

Land thus designated as mineral to be open to the location of mineral claims only, and land designated as nonmineral not to be opened to the location of mineral claims unless land designated as nonmineral be proved to contain mineral.

In making this addition, it was contemplated that there would have to be a definition of "mineral." The idea of the meeting was to provide means for the location of mineral claims on unoccupied lands classified as "nonmineral," if "mineral" should actually be found therein; moreover, to provide for the location of claims on public lands that have not yet been classified.

Article 2 was amended so as to make mineral claims 1,320 ft. square; that is, 40 acres.

Article 4 was amended so as to make the annual assessment work $200 on a 40-acre claim, with the proviso that $300 per claim may be paid annually into the United States land office in lieu of the performance of such work.

The last sentence of Article 5 was rewritten as follows:

And the holders or patentees of claims heretofore located to have similar exclusive possession of all the mineral in said claims that is not covered by any existing extralateral rights.

Article 5 as drafted and amended abolishes extralateral rights in so far as any claims hereafter to be located are concerned. The extralateral rights of existing claims may not be taken away, however, wherefore any new location and grant of patent may be made only with the reservation of such rights. The rights of existing claims having been thus expressly preserved, the last sentence of this article confers upon previously located claims the rights to everything comprised within the vertical projection downward of their side lines that is not legally claimed by anybody else, this being thus an addition to the original extralateral rights.

The Council of the Mining and Metallurgical Society of America has referred to the Society's committee on mining law the memorandum adopted by the New York Section, has authorized the immediate publication and has invited general discussion of it.

Kennecott Copper Corporation

The report of the Kennecott Copper Corporation is published, covering the period from May 27, 1915, when the corporation began operations, to Dec. 31, 1915. On Feb. 1, 1916, the initial dividend of $1 a share was declared. This required a cash disbursement of $2,780,583, and after its payment there was on hand in cash, or cash assets and copper, in excess of $13,600,000. This does not include the corporation's interest in the cash and copper on hand and in transit, of the Braden Copper Mines Co. or Utah Copper Co. nor its equity in the Alaska Steamship Co. and the Copper River & Northwestern Railway Co. In this estimate of cash assets copper to the extent already sold has been carried at the net selling price which the corporation will receive therefor; to the extent not sold, it is valued at 22½c. per lb.

The Kennecott Copper Corporation was incorporated Apr. 29, under the laws of the State of New York. On May 27 it acquired the entire property, assets and liabilities of the Kennecott Mines Co., and also the entire property, assets and liabilities of the Beatson Copper Co.

The properties so acquired have been producers for the last five years, with ore reserves steadily increasing in extent, but in order to confer an increased measure of stability, it was deemed wise to make an investment in shares of copper-mining companies in other fields, whose properties had been demonstrated to contain ore reserves of such large tonnage as to give assurance of long life. It was also believed advisable to acquire ownership of all the stock and bonds of the Copper River & Northwestern Railway Co. and a substantial holding of the stock of the Alaska Steamship Co., thus not only securing protection in essential transportation facilities, but also acquiring properties with earnings fully justifying the investment. In pursuance of this proposal the following purchases were made: 404,504 shares of Utah Copper Co.; all or part of the outstanding shares, bonds or debentures of the Braden Copper Mines Co.; from the Alaska Syndicate all the outstanding stock and bonds of the Copper River & Northwestern Railway Co.; and of 13,000 shares, out of a total outstanding capital of 30,000 shares, of the Alaska Steamship Co.

The Alaskan Properties Owned

The Kennecott mines are about three miles from Kennecott, Alaska, the terminus of the Copper River & Northwestern Ry. The two principal mines of Kennecott are the Bonanza and Jumbo, which are about one mile apart. The altitude at Kennecott, where the mill is situated, is 2,200 ft., while at both the mines it is 6,000 ft. Each mine is connected with the mill by an independent aërial tramway.

The Beatson mine is on Latouche Island, Prince William Sound, Alaska, and is one-half mile from deep-water transportation.

The total number of feet of drifts, crosscuts, raises, winzes and inclines in the Bonanza mine is 10,504 and in the Jumbo mine 9,692. The concentrator has a capacity of 700 tons per 24 hr. It is equipped with Blake and Symons crushers, bull jigs, rolls, Hancock jigs, Wilfley and Deister tables. The average grade of ore milled was 10.20% copper. The average recovery was 84.67%. The concentration ratio was 6.27, and the average grade of concentrates produced was 54.1%.

The concentrates and the crude ore that does not require concentration are shipped to the Tacoma smeltery.

An ammonia leaching plant is being built to treat the tailings from the concentrator. It is expected that a profit of $1 per ton of tailings treated will be made on 14c. copper.

The Beatson mine is also fully equipped. There is a concentrator at this mine, having a daily capacity of about 700 tons and employing only the oil-flotation process. The concentrator was put into operation in May, 1915. Before that time only crude ore was shipped. The average grade of ore milled was 2.23% copper. The average recovery was 77.17%. The concentration ratio was 9.21 and the average grade of concentrate produced 15.87%.

The Kennecott mines are served by the Copper River & Northwestern Ry., the ore and concentrates being hauled 196 mi. to Cordova, the ocean terminus of the railroad. Service is maintained on both railroad and steamship lines throughout the year.

The Beatson mine is on tidewater, and its product is shipped direct from Latouche, which is an open port during all seasons and shipments are steadily maintained throughout the year.

At the Bonanza and Jumbo mines at Kennecott the mining is underground and operations are carried on uninterruptedly throughout the year. At the Beatson mine at Latouche both underground and open-cut mining are carried on.

Production and Costs of Alaskan Copper

The corporation's mines in Alaska produced during the seven months of its operations ended Dec. 31, 1915, approximately 63,000,000 lb. of copper at a cost of less than 5c. per pound. Of this but 57,555,183 lb. was received at smeltery and taken into profit and loss. The balance was en route and is carried at actual cost of mining and milling. Total costs on poundage received at smeltery were as follows:

	Per Lb., Cents
Mining and milling	1.19
Freight to smeltery	2.18
Smelting and refining	1.37
Selling	0.18
General expense	0.06
Marine insurance	0.09
Proceeds silver contents	*0.52
Miscellaneous earnings	*0.01
	4.54

*Deduction.

The average copper content of product shipped from both mines during the seven months was 60.11%.

Braden Copper Mines

The Braden owns at Sewell, Chile, 2,362 acres, and at Rancagua for railroad terminals about 16 acres. At the present time it also has a concentrator with capacity of 4,400 tons of ore per day, its own complete smelting plant, hydro-electric power plant, and a village for housing its employees. The entire property is in the province of O'Higgins, Chile. The terminal of the mine's railway at Rancagua is about 48 mi. southeast of Santiago. The principal groups of mines are known as Teniente, Fortuna

and Centinela. The company owns its own railroad, running from Sewell to Rancagua, a distance of about 45 mi.; at Rancagua it connects with the government-owned railway which runs to Valparaiso on the seacoast. The ore in the mines is a concentrating copper ore in the form of sulphides of copper in a brecciated andesite; the ore-bodies occur around the periphery of an extinct volcano.

Pope Yeatman, consulting engineer of the Braden Copper Co., estimated as of Jan. 1, 1915, 113,694,880 tons of ore, with an assay value of 2.84%, and allowing for dilution in mining, he reduces this value to 2.5%. He estimates the life of the mine 32 years, with a plant having a capacity of 10,000 tons of ore per day.

During the last quarter of 1915 there was milled 382,553 tons of 2.16% ore and the production was 11,236,470 lb. of copper at an average cost of 7.9c. per lb.

It is proposed to increase the present capacity of the mill, which is about 4,400 tons of ore per day, to 10,000 tons per day. When this plant is completed the production will amount to 136,800,000 lb. per annum.

Ocean and Rail Transportation

The Alaska Steamship Co. has a fleet of 15 steamships operating between Puget Sound ports and various ports in Alaska. They connect with the Copper River & Northwestern Ry. at Cordova, with the Juneau Steamship Co. at Juneau, and in addition with the White Pass & Yukon Ry. at Skagway, the Alaska Northern Ry. at Seward, the American Yukon Navigation Co. at St. Michael, and with local boats at other ports for various points. The company operates under a regular schedule, both summer and winter, to all but the most northerly ports, such as Nome, St. Michael, etc.

The Copper River & Northwestern Ry. is a modern, standard-gage road running in a northeasterly direction in the Copper River valley to Chitina, a distance of 132 mi. from Cordova, thence in an easterly direction following the Chitina River to Kennecott, a distance of 64 mi. from Chitina and a total distance of 196 mi. from Cordova. It is open to traffic the entire year. The major part of the road is built on a water grade. It has a complete telegraph and telephone system along its entire line and adequate dockage and wharfage facilities. The railroad traverses what is known as the copper mineral belt of Alaska and within a few miles of the Bering River coal fields. The ocean terminus of the railroad, Cordova, is a landlocked port, open the year round. The road connects with the Alaska Steamship Co. at this point.

The income account for the period May 27 to Dec. 31, 1915, shows operating revenue from copper and silver produced $10,656,847; net income, less operating expenses, $7,709,504. After paying interest on bonds, taxes, and setting aside for depreciation of construction and equipment $169,338 and depletion of mining property $430,661, there is left a balance of undivided profits, Dec. 31, 1915, $6,573,797.

Mexican Mining Taxes

The State Department, at Washington, is in receipt of a telegram from Mexico City stating that the new taxes on mining properties will go into effect on July 1, 1916. With reference to precious-metal mines the following rates will prevail: 1 to 10 pertenencias, 6 Mexican gold pesos each per annum; 11 to 50 pertenencias, 12 pesos each; 51 to 100 pertenencias, 18 pesos each; over 100 pertenencias, 24 pesos each.

With reference to nonprecious-metal mines the following rates will prevail: 1 to 50 pertenencias, 6 Mexican gold pesos each per annum; 51 to 200 pertenencias, 12 pesos; 200 to 500 pertenencias, 18 pesos each; over 500 pertenencias, 24 pesos each. The export tax on silver and gold will be 10% ad valorem, and the state tax will be raised to a maximum of 2%.

United Zinc Smelting

The United Zinc Smelting Corporation was chartered on Apr. 18, under the laws of New York, with 600,000 shares of no par value, to acquire control of the zinc-lead mines of the Kenefick Zinc Corporation in the Joplin district, and of the smelting plant of the Clarksburg Zinc Co., at Clarksburg, W. Va., and to conduct a general mining, smelting and manufacturing business.

Raymond, Pynchon & Co., acting as syndicate managers, state that the offering of securities of the United Zinc Smelting Corporation has been over-subscribed and the subscription books closed. The Kenefick Zinc Corporation properties include the following mines in the Joplin district: Media (new mill only recently completed), Electrical, Coyote, Airedale and Milan; these properties are estimated to have an annual output of 25,000 to 30,000 tons of concentrates, and there are no outstanding bonds or other liabilities other than current indebtedness. The zinc-smelting plant of the Clarksburg Zinc Co., controlled by Pearlman Co., Inc., contains 3,648 retorts comprised in four blocks of 912 retorts each. It is planned to construct two additional blocks, bringing the total equipment up to 5,472 retorts. A new acid plant will be an important feature of the improvements at this works.

The officers of the United Zinc Smelting Corporation will be: President, William Kenefick, of the Kenefick Zinc Corporation; vice-president, Russell A. Cowles, of the Buffalo Copper and Brass Rolling Mills; vice-president and treasurer, Arthur Day, of the Kenefick Zinc Corporation. The subsidiary companies will retain their corporate organizations for the present. The offices of the new holding company will be 115 Broadway, New York.

Baltic Mining Co.

In 1915 the Baltic Mining Co., Painsdale, Mich., produced 12,028,947 lb. of copper, according to its annual report. The net profit from the year's operations was $949,965, and there was a balance of $1,440,516 in quick assets at the close of the year.

There was stamped 378,443 tons of rock, from which 12,028,947 lb. copper was produced, or a yield of 31.79 lb. per ton. The cost of copper was 9.5c. per lb. and the average selling price 17.4c. Of 468,315 tons of rock hoisted, 89,872 tons, or 19.19%, was discarded by sorting. During the year 54,240 cu.yd. of stamp sand was run into the mine for filling. The increased yield per ton over previous years is mainly due to the improvement in underground sorting.

Sea Water for Concentration is being used at the plant at Moonta mines and pipe lines have also been laid for its use in fire service at various points, as well as for general purposes at the mechanical shops and stables.

Editorials

Reform of the Mining Laws

Heretofore the agitation with regard to the reform of the present mining-land laws of the United States has been destructive rather than constructive. It has been the consensus of opinion that the extralateral and discovery-prerequisite features of the present law should be abolished, and moreover that the law should be revised in whole, not merely in a piecemeal way. But there has been no proposal, both broad and intelligent, as to what should be substituted. Indeed there has not yet been consideration of the defects of the present law with respect to the location of tunnel sites and mill sites, the conflicts between placer and lode locations, the principle and performance of assessment work, the recording of claims and the lack of provision for appeals to the courts from decisions of the administrative officers. To be sure, an excellent bill has been introduced by Senator Smoot at this session of Congress, but it does nothing more than to provide for the abolition of extralateral rights in a very simple way and to provide for the proper recording of claim locations. The broad bill introduced by Doctor Foster in the House of Representatives has met with nothing but the ridicule that it deserves.

A comprehensive constructive program for the reform of the mining-land laws was introduced at a recent meeting of the New York Section of the Mining and Metallurgical Society of America, report of which is to be found elsewhere in this issue. Everybody interested in mining is urged to read that carefully. Let it be particularly noted, however, that the actions then taken were not the actions of the Mining and Metallurgical Society of America, but only of the New York Section thereof, publication at this time being authorized by the Council of the Society in order to throw the subject open for public discussion. Criticism and discussion by everybody interested is earnestly invited, it being hoped thereby to obtain a consensus of ideas as to principles to serve as a basis for the drafting of an actual bill to be introduced in Congress.

For convenience we shall in this editorial refer to the document introduced on Apr. 19 simply as the Memorandum. It is obvious that the drafters of this had no intention of pressing particular points outside of the main lines upon which nearly everybody is agreed in principle, but contemplated merely the presentation of a series of specific suggestions which mining men in general should begin to discuss. They had in mind, of course, the abolition of both the extralateral rights and the discovery-prerequisite features of the present law, but in other respects, especially as to administrative features, the idea manifestly was to make the least possible departure from the present law and to retain the phraseology of the present law to the fullest possible extent, thus utilizing the decision of the courts as to the meaning of terms, etc.

If discovery is not to be a prerequisite to location, it follows that there must be, as soon as possible, an official classification of the public lands into those that may be taken up by mineral claims and those that may be taken up otherwise. Previous to the completion of such a classification, however, there must be means for the location of mineral claims upon unclassified lands that anybody may desire to prospect. Moreover, there must be provision for the location of mineral claims upon lands classified by the Government as nonmineral (and retained by it) if the existence of mineral therein should be proved. In this connection there must be some definition of what is meant by "mineral." This article is naturally one of the most difficult to write properly, and as framed in the Memorandum, was probably intended to be no more than suggestive.

In its second article the Memorandum proposed that mineral claims hereafter located be 660 ft. square—that is, 10 acres in size—with boundaries running north and south and east and west, such claims, when located on surveyed land, to be subdivisions of the surveyed sections. The 10-acre unit is the legal unit of placer claims under the present law (see Section 2330 and Land Office Regulations 22-24 of Mar. 29, 1909). In Section 2329, it is provided that where the lands have been previously surveyed by the United States, the entry of a placer claim, in its exterior limits, shall conform to the legal subdivision of the public lands. This is just what is done in article II of the Memorandum. The provision that claims located on unsurveyed lands coincide with the cardinal points of the compass is something new, but simply in line with the long-existing policy of the land office that it will not permit or sanction entries or locations that cut the public domain into long narrow strips or grossly irregular or fantastically shaped tracts.

According to the present statutes relating to mineral lands, placer locations are made for placer deposits properly speaking, for petroleum lands, for saline lands and for lands valuable for building stone; in short, for about all kinds of mineral deposits except mineral lodes and coal lands. Apparently, the framers of the Memorandum contemplated making the existing placer-claim unit the basis for all locations, including those that are necessary for tunnel sites and mill sites. Possibly they did not mean it also to apply to coal lands, but if such exemption were intended, it is not so stated.

The New York Section amended the claim unit to be 40 acres instead of 10 acres. There is precedent both for large claims and for small claims. The Mexican unit—the *pertenencia*—is about 2½ acres. The British Columbia claim is 1,500x1,500 ft.—that is about 51½ acres. It may be remarked that the present law of British Columbia was itself a substitute for an extralateral law, just as it is now proposed to make a substitution in this country.

There are good arguments in favor of both the large and the small square claim, but we think that those in favor of the small claims are the better. They give more elasticity in making locations: It is just like the subdivision of coinage. Business can be transacted better when there are small coins—dimes, nickels, etc.—for making change than when the smallest piece is a quarter.

Anyone who desired to take up 40 acres could of course take up four "tens."

Article III of the Memorandum sets no limit upon the number of claims that may be located by one person. As to the wisdom of this there will be much discussion, and properly so. These are times of great operations when large areas are necessary as a basis for proper development. The principal of unlimited location has worked well in Mexico. Yet the danger of claim-hogging is one to be considered. The essential feature of Article III is the abolition of discovery as a prerequisite to location, a reform as to which almost everyone is agreed. Recognizing that new principle, it might be feasible to set a limit to locations when discovery had first been made, but permit unlimited locations under other conditions.

Article IV, as to assessment work, was properly amended by the New York Section so as to make the requirement at the rate of $5 per acre as at present. New features are the permission given to the claim holder to pay a sum into the Land Office in lieu of assessment work, providing a means for the holding of claims when assessment work may not be done conveniently; but in order to adhere to the spirit of the present law which looks to the development of the natural resources, the payment of cash in lieu of work is discouraged by making it half as much again. The principle of the cumulative crediting of assessment work is taken from the British Columbia law. The other new feature, namely, the concentrating of assessment work upon a single claim and thereby holding a group, simply states what the courts have already ruled in certain cases, the present law being vague with regard to this matter.

It will be observed that the Memorandum makes no provision for tunnel sites and mill sites. If the prerequisite of discovery be abolished, there is no reason why the man who wants to drive a tunnel or build a mill should not take up the necessary land as a mineral claim if it be in mineral land; if in nonmineral, he may take it up in some other legal way. There ought to be some provision, however, in a new law whereby in the granting of further claims there should be a reservation by the Government of right of way for legitimate purposes of mining, and provision for the acquiring of such right by private persons. In certain parts of the country that is already possible under the terms of state laws, but in some states that is not so.

Article V abolishes extralateral rights in any future locations. Of course there may be no subtraction of extralateral rights already possessed. This necessitates a qualification of the rights to a claim in certain conditions under a new law. Suppose that a new claim *B* were located beside an old one *A* and suppose the vein of *A* were found to dip into *B*, the owner of *A* would have the right to follow it into *B* and the grant of *B* would necessarily be with that reservation. The law should further provide that for the mining of such an extension the owner of *A* should have the right to excavate in the foot wall in *B*, in order to avoid such a complication as happened at National, Nev. But there is another contingency. Suppose a vein were discovered in *B* and dipped into *A*. The owner of *B* would have only the portion comprised within the vertical projection downward of his side lines. The owner of *A* would have no claim to the extension under the existing law, for he would not have the apex. Article V proposes to settle such a point by preserving to *A* all existing extralateral rights and moreover, conferring upon it everything comprised within the vertical projection downward of its lines that is not covered by any existing extralateral rights. These provisions are comprehensive and ought to be satisfactory to everybody.

Article VI provides for the filing of notices of location within a year and the termination of all rights if final entry be not made within seven years—two simple but necessary provisions that are taken from Senator Smoot's bill now pending in the Senate.

It is desired and hoped that all of these points may receive very full discussion. Our columns are open for that purpose.

Respecting Interchange of Information

On several occasions of late we have referred to the backwardness of Great Britain in the metallurgy of copper, lead, tin, zinc, etc.—indeed in most branches of the metallurgical art save iron and steel. We have pointed out the blight of labor conditions existing there as being one of the factors in this, being well aware that there were of course others. One of the others is the secrecy that is maintained respecting the works of the country and the adherence to a policy that is all but incredible. Not long ago we had some correspondence with a very distinguished British metallurgist with regard to a technical contribution that we conceived would be of general interest. His reply to one of our letters was both interesting and illuminating. Thus, he wrote:

> I thank you for your invitation to contribute an article and regret that I cannot do it—regret the fact and regret the reasons. It is a curious thing that in this country it is only the large-scale industries like iron and steel that have any sort of interchange of knowledge, experience and ideas. The smaller works and the most backward ones are as jealous as cats and as seclusive as oysters. They may and do work together in matters commercial, but they usually close their works to one another, do not speak of any technical things and do not encourage or even permit any interchange among their technical staffs. I think I may safely say that this state of affairs is at its worst as regards the ———, which are generally small and have inherited very bad traditions.
>
> I have now been connected with this branch of metallurgy in England for many years and have never had the chance of knowing anything of any works I was not connected with. In my own district there are several other works. I have not seen any of them and do not know anybody connected with them. Their owners would have a fit if a visit from me were proposed, and I think my owners would conversely be likewise affected. It is deplorable, it is also humiliating as an attitude, but there it is!
>
> With your works things seem to be just the reverse. All information seems open, and managers are allowed to give full accounts of all they are doing, as befits those huge concerns with great capital and immense and secure supplies of ores. To read of metallurgical developments in America—in copper notably, of late years—is a sort of romance to a man who has spent his life in the comparatively petty work of old and small concerns with their very narrow limitations. It is fascinating, but also not a little depressing, as you will readily understand.

Where would American metallurgy have been if our corporations had not learned the advantages of interchange of ideas? We still have some works that are operated under the tradition of a former generation, when the ideas of secrecy obtained here as they continue to obtain in Great Britain. There is a general suspicion, however, that secrecy in any American metallurgical works is a veil to conceal bad practice, and in more than one instance that is known to be the case.

BY THE WAY

An engineer had taken over an old abandoned mine with a view of opening and operating it. One day while on a tour of inspection of some of the old workings that had formerly been very heavily timbered, he was accompanied by a "Cousin Jack," who had been in his service for a number of years. Jack stopped, squinted along a line of stulls, then asked: "Damme, lad! what for fashun timberin' do 'e call that—neither plumb, paralyzed or in rotation?"

⁂

The manager of a metallurgical plant that has frequently been described by visitors, generally with inaccuracy, has written us the following pertinent letter:

The description of the works by B——— S. C——— in the ——— of Dec. 10 is incomplete and inaccurate. I do not want to go into detail pointing out the omissions and mistakes, but I should very much appreciate, if in future, visitors who like to write about what they have seen at the plant advise me of their intentions. It is not possible to write much worth printing after just having walked around the works for an hour or so; but if asked for, the necessary detailed information would always be supplied with pleasure.

This is from an unusually broad-minded manager. We fear that the majority of managers would not be so liberal. His point about incomplete and inaccurate descriptions seems to be well taken. There is no doubt that there is too much careless writing by casual visitors about the things they think they have seen.

⁂

Henry Ford, after a visit to Louis Enricht, the Farmingdale, L. I., chemist who claims to have discovered means of using "doped" water to generate power for running gas engines at cost of 1½c. per gal., said, according to a newspaper special, "I'll match my time against any man who has an idea. I believe this man knows what he is talking about. He convinced me that he is absolutely sincere." New Ford car on which Enricht will make further experiments was shipped to Farmingdale. The inventors of all devices for perpetual motion will look to Mr. Ford as the Mæcenas of their craft. E. D. Lewis, an Elmira inventor, is already in the field. He is reported as claiming that by putting an ounce of sulphuric acid, costing just 2c., into a gallon of water, and equipping this mixture with two electrodes, connected to a battery, hydrogen can be set free. This gas, he holds, will make as good fuel as gasoline. This ought to be as good as the ounce or two of "green fluid" that Colonel or Professor Enricht uses.

⁂

The good old rule that every rise in the price of a commodity is due to the machinations of some trust has its exponents still, as is shown by the rush in Congress to bring the oil companies to book for the high prices of gasoline, remarks the *Evening Post*. It was begun in the House by Steenerson, of Minnesota; it was carried into the Senate by Martine, of New Jersey, and Hitchcock, of Nebraska. If members of the Senate would turn to their own Document No. 310 they would find information to show that there is no reason for panicky assaults upon the large oil corporations. The Secretary of the Interior traced the disparity between supply and demand in gasoline to causes both natural and evident, and translated the effects of those causes into cold figures. He stated that it was possible that financial manipulation by various interests might have played a slight part in the rise, but that it could be only the slightest. Every gathering of chemical or mining experts or men interested in motor fuels results in agreement that the cost is due to decreasing production and rapidly mounting consumption, and is inevitable.

⁂

In the famous Case of Mines, brought by Queen Elizabeth's attorney against the Duke of Northumberland, in the eighth year of her reign, it was eventually decided that the mere presence of gold and silver in a deposit made it a Mine Royal, but if they were totally absent, the royal prerogative was of no effect, says the London *Financial News*. Commenting on this the reporter (Plowden) affirms "that there are but six kinds of metal in the earth; viz., gold, silver, tin, copper, lead and iron. These six are engendered by the coition of quicksilver and sulphur, such being the ordinance of God. Gold is the son of sulphur and quicksilver. Silver is the daughter of the same union, less noble than her brother, gold. And the other metals, viz., tin, copper, lead and iron proceed from their said father and mother. They have by accident become imperfect, *veluti leprosi filii ex leprosis parentibus*—like leprous sons from leprous parents." All mines, he adds, carry gold and silver in some proportion, so that the resolution of the court "is grounded upon an ignorance of the nature of base-metal mines." Well, anyway, we hope the clerk of the court isn't going to add anything to the Minerals Separation cases.

⁂

We have previously remarked about New York being the only one of the world's great capitals within whose limits a mine has actually been worked. We referred of course to the iron mine of Staten Island, which has been operated as recently as during the last 10 years. In a recent publication by the Staten Island Antiquarian Society, Charles Gilbert Hine gives some interesting details of this. The "Yserberg" of Dutch nomenclature, "Iron Hill" of the English, was worked for ore as early as 1644. The ore was limonite, or bog ore, occurring in surface pockets; therefore no signs remain of early exploitation except the shallow basins from which the ore was dug. The height was once known as Toad Hill, and "Toad Hill paint" is an expression found in old documents. The red, oxidized earth was mixed with whitewash by old settlers who wanted color. It was also supposed to possess the virtue of giving durability to the wash. The name "Toad Hill" is one of several variants of an original at whose identification numerous attempts, never quite satisfactory, have been made. The writer of the present note saw ore being dug from these pits about 35 years ago, and as noted, some has been dug during the last 10 years, but operations during the last 50 years have been but spasmodic. Even nearer to the heart of New York is the old copper mine of Arlington, N. J., the locus of which may be seen from our office windows.

⁂

Two preposterous bills, one introduced by Mr. Tavenner, of Illinois, and the other by Mr. Van Dyck, of Minnesota, make it unlawful for any Government officer to use a stop watch or make a time study of the job of any employee. The preamble of Mr. Tavenner's bill is worthy of record on this page:

Whereas, A stop watch is used in timing workmen while at work to ascertain the maximum amount of work possible for the most capable man in a given time and making this the

"standard time" in which work must be done, and by a system of premiums and bonuses, together with disciplinary measures sufficiently severe to enforce the system, this "standard time" is the speed to which all workmen must eventually attain if they are to retain their employment; and

Whereas, Experience has shown that the American workman by his exceptional celerity performs about twice the work performed by the manual worker of other countries, with the concomitant condition that the ratio of accidents here is from three to four times as high as in other countries; and the tendency of so-called "scientific management" through the above timing and bonus features will be to further aggravate the accident disabilities and mortality aforesaid and reduce the workman to a mere mechanical, instead of a social and moral, relation to his work, and, moreover, are unnecessary to secure adequate efficiency of labor; and

Whereas, By a stop-watch time study you may be able to determine the time in which a piece of work can be done, but you do not thereby determine the time in which it ought to be done.

Therefore, the stop-watch must not be used. Verily many members of Congress must have a hard time in running the gauntlet between the fool-killer and the walking-delegate, the incarnation of whom is one Samuel Gompers sitting threateningly in Washington.

⁂

J. A. Comer & Co., Inc., has a method of assaying which recovers all of the metal in the ore and not merely the portion shown by the old-fashioned fire assay. Some of the results attained are referred to on page 255 of the *Journal* of Jan. 30, 1915, Massachusetts "pudding stone," for instance, giving $1.60 by fire assay and $24 by the Comer method. Ore from Vermont showed $4 and $36 by the two methods, Alaska concentrates, $16.53 and $90.65, and so on. In forwarding a recent advertisement of J. A. Comer & Co., Inc., in which old-fashioned fire assays are listed at $1, Comer assays at $5 per throw, cash strictly in advance, one of the *Journal* subscribers says:

It looks as though our old-time methods would have to give way to modern science, especially if this advertisement becomes widely circulated. The amount of time that has been expended in research work must go for naught in view of the upheaval in scientific circles that will be caused when this information becomes known. Those engineers who locate a mass of gold by the mere flop of a hazel twig will, with this new method to fall back upon, be able to make complete returns on all prospects. Like all good things it comes high, but I presume this should be expected in view of the enormous amount of time that must have been spent in research that led to the development of such a method. Again, why kick, when the new method is capable of giving returns that are six times greater than the old fire method, at only five times the cost. This new method is (pardon) a Comer, and it will be a pity to have it subjected to any criticism whatsoever by our scientific societies, which should, I think, vote it summa cum laude. It is not based on a fallacy, as was the method Callahan used in Los Angeles during 1906 and 1907. Callahan used a microscope and often persuaded people to give up their pursuit of wealth in mining ventures because the rock showed no gold or tellurium. Speaking of Callahan reminds me of a meeting of officers and shareholders I once attended at the request of one of the latter who hesitated to "pungle" up for another assessment. Callahan was the engineer and met with his employers to show them some of the trophies taken from the mine and to lend courage to the timid, never to abandon any tunnel after it had been driven half-way through a mountain. The microscope would convince all those present that "there were millions in it." There were 12 or 15 men present, among whom were the president, vice-president, secretary and treasurer of the mining company. At one side of the room was a table upon which were many specimens of the "wonderful ores," a compound microscope of uncertain age and an electric desk lamp with which to illuminate the specimens about to be observed. Callahan would select a specimen and, to show his scientific training, would give it the salivary once over, then place it upon the stage of the microscope. After adjusting the light and focusing upon a moist crystal of hornblende, those present would all pass around the table to view the wonders that nature had put into the desert hills for them. Using Callahan's words upon that occasion, "They were now viewing the purple of Cassius caused by the oxidation of the tellurium." As you are much better known throughout the mining world than I, it occurred to me that it would not be misunderstood if you called attention to the great losses that are taking place in the districts indicated in the advertisement.

This sort of thing seems contagious. J. A. Comer & Co., Inc., hails from Seattle, Wash., and now comes another man from the Northwest who has put his money into a mill and thus describes results:

I have been working on the Central Oregon volcanic scoria, or ash, for the past 17 mo. I long ago found that this material carried values in several kinds of metal, especially in gold, silver and platinum, but how rich the material was I found a very difficult thing to settle. Ordinary assaying always fell down on this ore, but after long and patient work, I came to the conclusion that an amount approximating $2.50 a ton could be recovered in gold and silver with varying amounts in platinum. Basing my work on this idea, I interested Will H. Bard, of Portland, in the matter, and since then we have made as many as 400 tests under many different conditions and using many different methods of extraction. After we proved to our own satisfaction that the values were really in the ore, we began building a mill in which we could treat enough of the ore to fully establish the values. This mill was built on the banks of the Deschutes River, 7½ mi. west of Terrebonne, Ore. We began operations about Oct. 1, and since that time our work has been redoubled and we have proved that we recover $5.07 in gold and silver from each ton of ore milled. We also made a very valuable concentrate. Now, the strange part of this matter is that an ordinary fire assay for gold and silver does not show much more than 10% of the actual values recovered in milling this ore. Chemists and metallurgists will, no doubt, dispute this fact, but we are here to prove that such is the actual fact. None of the gold is free. The deposit of this sand or ash covers at least 2,000 sq.mi., and the depth is more than 500 ft., or, say 1,250,000 tons to each acre of this territory. We have proved that there is a profit of more than $2 a ton in milling this ore. By figuring a little, you will see that here is the biggest gold discovery ever made, a hundred times over, and one where the man who builds a mill and operates it can absolutely know that his profits are sure. We have not incorporated any company or sold a dollar's worth of stock, therefore we are at liberty to state the facts as they exist.

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The engineer who has sufficient command of his work to be able to make estimates for his superiors in round numbers and thereby reach correct and rapid conclusions demonstrates the value of "preparedness" of a kind. It requires some experience and an exceedingly reliable sense of perspective to do this work well, but it is worth cultivating. To be able to give the "boss" an outside figure for temporary use that will stand the so-called "acid test of time" is to be indeed a master of one's profession, says *Power*. To do this kind of work, one needs to acquire an insatiable appetite for cost data and to learn to carry in one's head some of the basic figures of operation, first cost and fixed charges. A knowledge of the slide-rule is helpful, though not essential if a man is good at approximate calculations by mental arithmetic. Without seasoned judgment it is hazardous to offer figures of this kind, for there is always the probability that the "boss," having once received them, will use them as final in his later deals and dickers with the board of directors, outside manufacturers, competitors and other potentates. But often it is entirely possible for an engineer to prepare a rapid exaggerated cost estimate, making the items round and large enough to be on the safe side and thus to at least indicate the possibilities of the particular problem in hand. Not all engineers have the taste for these rough-and-ready approximations, but the man who can handle such work with a sense of proportion and with accuracy sufficient to establish the main points in record time is indeed to be envied.

PERSONALS

L. W. Goodwin, of Boston is at White, Georgia.

H. C. Enos, recently at El Paso, Texas, is now at Joplin, Missouri.

J. W. Stockham, lately at the Golden Age mine, is now at Boise, Idaho.

G. D. E. Mortimer, lately at Nelson, Nev., is now at Cotopasi, Colorado.

Frederick P. Burrall, lately in New York, is now at Dawson, Yukon Territory.

W. H. Geis, recently at Berkeley, Calif., is now at the Skidoo Mines, Skidoo, California.

S. F. Shaw is visiting Anaconda, Butte & Superior and Elm Orlu properties in Butte, Montana.

F. R. Van Campen, recently at Olean, N. Y., is now at the Beatson copper mine, Latouche, Alaska.

R. W. MacNichol, recently in San Francisco is now with the Commercial Mining Co. at Rye Valley, Oregon.

Frederick S. Porter, of Seattle, Wash., is now with the Alaska Treadwell Gold Mining Co. at Treadwell, Alaska.

John Seward, of New York, is investigating a mining property in Nova Scotia and expects to return about the end of April.

C. B. Lakenan and Pope Yeatman have been visiting the mines and mills of the Utah Copper Co., with R. C. Gemmell, general manager.

H. F. Black has been appointed assistant to president of the Midvale Steel Co., Cambria Steel Co. and Worth Brothers Co., effective Apr. 15.

Fred Hellman, general manager of the Chile Copper Co. at Chuquicamata, Chile, was recently at Salt Lake City, and went from there to San Francisco.

Harrison Prindle, formerly of South Chicago, is manager of the Lebanon Blast Furnace Co.'s furnace at Lebanon, Penn., which will soon be started up for the manufacture of manganese products.

Dan Griffin, foreman of the Steward mine, of the Anaconda Mining Co., is making an extended trip to California for the benefit of his health. Chas. Bonner is in charge of the mine during his absence.

R. B. Lamb is now consulting engineer for the Oatman Southern Mining and Milling Co. and the Pittsburg Mining and Milling Co., also of Oatman, Ariz. His present address is 25 Broad St., New York.

Newton Booth Knox has been appointed consulting engineer to a wolfram-tin mine in Spain, and has left London for the mine, expecting to be there about a year. His address is Minas de Phoenicia, Noya, Province de Coruna, Spain.

Allan J. Clark, B. C. Yates and W. J. Sharwood, of the staff of the Homestake Mining Co., at Lead, S. D., have been chosen members of the South Dakota advisory board of the National Preparedness Association. At a recent meeting Mr. Clark was designated secretary of the board.

F. L. Boardman, who was formerly foreman in charge of U. S. Bureau of Mines Mine Rescue Car No. 5, has resigned from the Government service to enter the service of Anaconda mining company. He will be employed in the Bureau of Safety, and will have charge of all first-aid and mine-rescue work.

The Tacoma Exploration Co. has established offices in the Bank of California Building, Tacoma, Wash. The company will take up the examination and development of mines and prospects. W. R. Rust, formerly president of the Tacoma Smelting Co., is president of the company; L. A. Levensaler, manager; and G. W. Duncan, secretary.

Thomas Hoatson, president Calumet State Bank, Calumet, Mich., with a party of friends recently visited Sutter Creek, Calif., being the guests of T. Walter Beam, manager of Consolidated Amador mines. Mr. Hoatson is one of the subscribers to the purchase of the mine which was formerly known as the Old Eureka, from Hetty Green.

Robert J. Raley has resigned as district sales manager of the Sullivan Machinery Co. for the Lake Superior iron and copper ranges, with office at Duluth, Minn. John F. Berteling succeeds Mr. Raley as district sales manager and will have his headquarters at Ishpeming, Mich. Mr. Berteling is a graduate of the Michigan College of Mines and has been in the district with the Sullivan Machinery Co. for five years past.

OBITUARY

Abraham Houghtaling, 86 years old, died at San Francisco Apr. 4. He was born in New York and left there at the age of 20 for California having a stormy voyage around the Horn. Mining in Amador County engaged his attention for some years.

F. Anton Siebert, pioneer resident of Columbia, Calif., died at that place Mar. 29. He was born 82 years ago in Bastadt, Baden, Germany, in 1834. He came to America at the age of 18, resided in Boston and a few months later joined the rush of gold seekers to California. He went to Stockton and later to Tuolumne County and engaged in mining near Columbia. He was one of 12 men who operated the old Tiger mine in Main Gulch, one of the richest gold mines in that rich period of California placers. Mr. Siebert also followed the Fraser River excitement, but returned to Columbia. Later he gave up mining and devoted his time to commercial pursuits.

William R. Thomas died at Catasauqua, Penn., Apr. 13, aged 88 years. He was born in Wales. Coming to this country, he started to work in a machine shop at Beaver Meadow, and after a varied experience, became superintendent of the Crane Iron Works, now owned by the Empire Steel and Iron Co. For some years he operated iron plants in the South and later was consulting engineer for Davies & Thomas Co., who built miles of cast-iron tubing for the New York and Philadelphia subways and the Hudson River tunnels. He received one of the first patents ever issued for a gas engine, and also had patents for milling, furnace and automobile machinery.

Andrew Long Horner, general manager of the Springfield Tunnel and Development Co., in Tuolumne County, Calif., died at Sonora on Apr. 16. Mr. Horner was born in Pennsylvania Dec. 19, 1849. He had been identified with large mining enterprises in California and other Western States and Alaska, and for the past nine years was at the head of the company operating the Springfield tunnel on Table Mountain. He engineered a great undertaking and approximately coincident with his death had reached the end of the struggle for the opening up of one of the largest ancient channel gravel deposits in California. At least the engineering problem has been worked out and only additional labor is necessary to complete the enterprise. Mr. Horner's home was in Oakland where his wife survives him.

Joseph Henry Collins died Apr. 12 at his residence, Crinnis, Par Station, Cornwall, England. He was a member of a well known family of mining engineers and was himself an engineer of high reputation, of wide experience and high standing. Born and brought up in Cornwall he was from 1868 to 1880 chief chemist and metallurgist of the Rio Tinto company in Spain. Since 1881 he had practised as consulting engineer and mine manager in London, and had inspected and reported on mines in Norway, Sweden, Spain, Hungary, Mexico, Canada and the United States, besides managing several Cornish mines. He was for a number of years head of the firm of J. H. Collins & Sons, of London and Cornwall. He took an active part in several technical societies and had been president of the Institution of Mining and Metallurgy, the Royal Geological Society of Cornwall, the Royal Cornwall Polytechnic Society and the Royal Institution of Cornwall. He was a close student and careful writer and was the author of several books on the geology and mineralogy of Cornwall, besides a number of papers on mining and metallurgical subjects, and many lectures.

SOCIETIES

Colorado School of Mines—The seniors leave Golden on the annual trip of inspection to the mining and metallurgical camps of Colorado, Utah and Montana, Apr. 24, and will be gone until May 23 when they will reach the school just in time for graduation. The itinerary is practically the same as for years past, including Colorado Springs, Portland, Cañon City, Leadville, Breckenridge, Shoshone, Glenwood Springs and New Castle, Colo.; Castle Gate, Salt Lake City, Bingham and Garfield, Utah; and Butte and Anaconda, Mont. Several members of the faculty have been notified of their dismissal to be effective at the close of this college year, this being in line with the policy adopted by the board of trustees last year when Dr. Phillips was appointed to the presidency and given authority to reconstruct his faculty.

Editorial Correspondence

SAN FRANCISCO—Apr. 19

Natomas Gold-Dredging and Reclamation Projects, under the general management of Emery Oliver, have been approved by Frank B. Anderson, president, and Directors Judge Curtis H. Lindley, John D. McKee and W. Mayo Newhall, who recently visited the ground and the dredges at Natoma where L. D. Hopfield is field manager. Mr. Anderson stated that the work is progressing satisfactorily and that all of the details of the reclamation project are being carried through on schedule time. Improvements have been made on Natoma No. 4 dredge which recently went into commission, equipped with two tailing stackers for the proper distribution of tailing, in the reclamation of ground dredged for gold and to be afterwards turned over to agricultural uses.

Unwatering Northend Comstock Mines to the 2,900 level is rendered imperative by the fact that high-grade ore has been disclosed below the 2,700 level and the water is within 6 ft. of that level. It has been necessary to open the old Union shaft from the 2,000 to the 2,700 level on account of caving between the 2,000 and 2,400. Immediately upon completion of this work, which should be reached by the end of May, Superintendent Symmes will probably report on the unwatering below the 2,700, so that his recommendation may be acted upon by the Comstock Pumping Association. The flow of water in the deep levels is much less than expected; below the 2,500 the flow is less than 1,000 gal. per min. There is no danger of sudden influx of water as has been feared.

The Argonaut, since the settlement of the apex suit, has been going along rapidly with the installation of a tailings dam, improvement of the metallurgical plant, and the installation of an underground hoist. It is expected that the Argonaut dam will be completed by the middle of May, whereupon the Bent Bros. of Los Angeles will raise the Kennedy dam an additional 25 ft. in height. The Eastwood multiple arch dam proved wholly satisfactory in the impounding of tailings of the Kennedy mill and this successful installation by the Kennedy Mining and Miling Co. induced the Argonaut Mining Co. to use the same kind of retaining dam for the impounding of tailings from the Argonaut mill. Before the apex suit against the Argonaut was settled, the company contemplated a system of disposing of tailings which would not require extensive construction but which would serve the purpose for a period of about 15 years. But since the successful operation of the Eastwood dam at the Kennedy mine, the Argonaut Co. determined to install the present system which will make a permanent retaining dam for practically all time.

Independent Oil Producers Agency handled 13,931,201 bbl. of crude oil in 1915 at a cost of 0.008c. per bbl. The operating expense totaled $66,883; appraisement committee, $43,356; depreciation, $1,774; reserve on oil sales, $90,573; balance for year 1915, $21,441. The agency is considering a plan to establish one or more Rittman plants in the state. Standard Oil reports state that the first quarter of 1916 was the most prosperous period the oil industry has known for about 2 years. This is shown by the amount of development work performed in the 3 months, which was close to a record for field activity. State Mining Bureau reports that 163 new wells were brought in from Jan. 1 to Apr. 8; and that many of these wells are in untested territory. Crude oil produced in all fields of California in March amounted to 7,525,081 bbl., according to the Independent Producers Agency. This is the largest monthly production since October, 1915. Shipments from the fields in March amounted to 8,368,869 bbl., thus reducing the stocks by 843,788 bbl.

BUTTE—Apr. 20

Blue-Sky Law Violations have been so frequent that the State Auditor has sent out a warning to stock brokers. This is interpreted to mean that the prohibition against the sale of certain oil stocks is absolute, and that other concerns will have to show satisfactory proofs that they have something more material than hot air. The investment commission has a list of 32 concerns selling oil stock in direct violation of the law and it is the intention of the commission to call a halt to this illegal traffic.

The Workmen's Compensation Law of Montana has just been reported upon by the state industrial board which states that during the nine months the new law has been in operation in Montana, it has more than fulfilled the promises made for it. The statement shows that 1,163 employers and over 60,000 employees now come under the provisions of this law. A total of 4,822 accidents was reported to the board. Of this number 107 were fatal. As a result of injuries 847 employees have received compensation while 3,948 returned to work before the compensation payments began. Although the payments under the compensation act are now averaging more than $1,000 per day, the board calls attention to the fact that accidents are decreasing in number and the safety-first campaign is having its effect. The consensus of opinion is that the new plan is much more satisfactory than the old liability method because the go-between or ambulance chaser is now entirely eliminated and whatever money the employer pays out, goes directly to the injured employee in its entirety or in case of death to his beneficiary. The new order has also resulted in many economies. The savings made in time of courts and juries is no small item. If the unusual and exceptional accidents, suffered by the North Butte Mining Co. in October, with the loss of 16 men, and by the Anaconda Copper Mining Co. in February, with the loss of 22 men, be excluded from the list, the average cost of compensation would be a little less than 20% of the cost existing in the most favored states.

DENVER—Apr. 21

A Large Body of Low-Grade Zinc-Carbonate Ore, perhaps the largest in the Leadville district, has been opened in the Gallagher property on East Carbonate Hill. The ore contains from 12 to 18% zinc and is an ideal ore for the manufacture of zinc oxide. The Western Zinc Oxide Co. has contracted for 10,000 tons of the output of this property.

The Roosevelt Drainage Tunnel has been connected with the Elkton shaft, in the Cripple Creek district, at a depth below collar of 1,640 ft. As soon as the shaft can be put into shape, it will be used as the exit for all rock broken from the breast of the tunnel which is being pushed ahead toward the Vindicator mine.

A Noticeable Feeling of Discontent exists among the Leadville miners, in spite of the fact that the mine managers and the smelters have raised wages about 10%. The miners feel that they are entitled to $3.50 a day, while the 10% increase gave them only $3.30. The extremely high prices now being paid for all metals mined in the camp, with the exception of gold and silver, are the foundation on which the miners place their demands. Miners throughout the Leadville district are not organized. There is a union here but its membership is small. Union men are now carrying on a campaign to get all the miners into the organization. A number of the men have joined the union but the majority are still considering the question.

United States Reduction and Refining Co. holdings were offered for sale Apr. 15 at Colorado Springs, pursuant to a decree of foreclosure. No sale was effected, however, the stipulation being set by the officer of court that no bid of less than $250,000 would be entertained. The properties offered were the the Standard plant at Colorado City, the Union and National plants at Florence, the Metallic at Cyanide, part interest in the Cripple Creek Sampling and Ore Co., the United States plant at Cañon City, the National Sampler at Cripple Creek, various mining claims in the Cripple Creek and Breckenridge districts, a 200-acre ranch in Fremont County, water rights, reservoirs, pipe lines, franchises, contracts, etc. Sale was postponed until Apr. 25.

SALT LAKE CITY—Apr. 20

Members of the Utah Committee to assist the Naval Consulting Board in the matter of industrial preparedness have begun plans for an industrial survey of the state. The committee consists of W. C. Ebaugh, representing the American Chemical Society; A. F. Parker, of Ogden, for the American Society of Civil Engineers; Lafayette Hanchett, representing the American Institute of Mining Engineers; Markham Cheever, chief engineer of the Utah Power and Light Co., representing the American Institute of Electrical Engineers; and William Wraith, of the International Smelting Co., representing the American Society of Mechanical Engineers. The above engineers, who have been appointed state directors by the Secretary of the Navy, after being chosen by five engineering societies, will begin as soon as possible with the assistance

of field aids, an inventory of the manufacturing and other industries of Utah that would be useful in case of war. The committee will be assisted by members to be selected from local commercial and professional bodies.

The Utah Apex, at Bingham, is one of the largest lead producers in Utah. The company made net earnings of $202,719 for quarter ended Feb. 29, 1916, as compared with $65,011 in the quarter preceding. Shipments are averaging over 350 tons of crude ore and 60 tons of concentrates daily. The flotation equipment, installed at the mill during 1915, has given better results than looked for by the management, showing a recovery of 90% of the lead. It has been decided to sink the Pervenu shaft to the 500-ft. level.

A Detailed Geological Investigation of the Cottonwood and American Fork mining districts will probably be undertaken by the U. S. Geological Survey during the coming season. Recently, Utah mining men sent in a petition for such an investigation and, according to Director George Otis Smith, this work stands first on the list of projects for the geological work of the Survey in Utah during the coming fiscal year. It is stated that all plans for the coming field season, however, remain in a tentative stage until the passage of the sundry civil bill. It is hoped that the topographic work, needed in addition to the published map of the Cottonwood district, can be started early in the season, and that geological work can follow closely after it.

EL PASO, TEX.—Apr. 21

Concessions by the State of Sonora Are Annulled by a decree issued today by Governor Calles, declaring void all foreign concessions and franchises. He also declared that no more remissions of taxes would be permitted. As previously indicated in these columns, this does not necessarily mean the permanent annullment of all franchises, but merely the enforcement of a financial expedient. In other words, with all the chips gathered to the jackpot there will be a new deal. Mining companies, such as the Cananea Consolidated Copper Co., holding their property by Federal concession, are affected only to the extent that operating and other concessions have been granted by the State of Sonora; these may be the subject of further negotiation. A conference has been called by Secretary Luis Cabrera, of the Department of Finance, of all mining men regarding the increase of 100% in mine taxes to take effect May 1.

JOPLIN, MO.—Apr. 20

Another Zinc-Smelting Works is to be erected across the river from Fort Smith, at Van Buren, Ark.; ground is being cleared and the works will have a total of 3,200 retorts, though also a four-block plant. This plant is being built by L. Vogelstein & Co., of New York.

One Thousand Tons of High-Grade carbonate of zinc was the output of the North Arkansas mining field for March; and many of the mines in the Rush Camp were unable to get their ore hauled. Good progress is being made on the Yellville-Rush railroad, which will eliminate this drawback to this camp. A traction engine that hauls 20 tons of ore at one trip is one of the recent innovations being tried out by the operators in an effort to get their product to market.

All Joplin District Records Were Broken for one week's shipments by the output of lead and zinc for the week ended Apr. 15 amounting to 27,401,280 lb. which sold for $1,433,827. This tonnage is about 10,000,000 lb. above the present weekly production and represents the previous week's cleanup of practically every pound of ore in bins at the mines throughout the district, 153 mining companies appearing in tne sales reports. Total production of the district for the first 15 weeks of 1916 amounts to 224,053,838 lb., which sold for $12,833,717, a sum that has been exceeded only nine times by any annual output during the last 50 years.

The Fort Smith Spelter Co. is rushing the construction of its new four-block zinc smeltery at South Fort Smith, Ark. The office, storehouse, ore bins, coal bins and the foundation for the four blocks have been completed, and brick laying has been started on two of the blocks. H. S. Buck, of Pittsburgh, Penn., vice-president and general manager, states that the plant should be making spelter by July 1. The plant is to have 640 retorts to the block, or 2,560 retorts in all, and will cost about $250,000. Natural gas will be used for fuel. Eastern men are reported to be behind the plant, but their identity cannot be learned here. It is rumored they are associated with the big brass interests. So far the company is discounting all its bills.

DULUTH, MINN.—Apr. 20

A Temporary Flood of Labor is reported by employment agents at Duluth, due to the influx of men from the winter's logging operations. The opening of the pit mines will rapidly absorb the entire surplus, however, as they will require from 8,000 to 10,000 more men on the Mesabi Range alone.

Interlake Navigation Opened at the American head of the lakes Saturday, Apr. 22. The movement of iron ore to the Duluth-Superior docks and Two Harbors docks is now in full swing. There are huge stockpiles at the underground mines on the Vermilion, Mesabi and Cuyuna ranges. Some of the mines, especially on the Vermilion are getting short of stockpiling room and are making their initial season shipments direct from the skips. It is estimated that the Duluth, Missabe & Northern will ship 21 million tons this season. Estimate for the Duluth & Iron Range road, with docks at Two Harbors, is 11 million tons. As near as can be ascertained the Great Northern road will ship 15 million tons, which includes all ore shipments over that system, and not merely from the Hill properties.

BRAINERD, MINN.—Apr. 19

On the Cuyuna Range, at least seven new properties will enter the ranks of shippers, this season, viz.: Croft, Meacham, Cuyuna-Sultana, Mahnomen (pit), Hoch, Ferro and Mangan. Shippers of manganiferous iron ore will be much in evidence, including Cuyuna-Mille Lacs, Cuyuna-Sultana, Ferro, Iron Mountain (recently renamed Hoch) and Mangan. If current statements are to be believed, these operations have sold, or can sell, their entire 1916 production at substantial advances over prevailing iron-ore prices. Of the above, the Cuyuna-Mille Lacs is the only one that has shipped any considerable tonnage prior to this season. Among the straight iron-ore mines, the Croft made its maiden shipment this month, being the first Bessemer ore shipper in the district. Adjoining the Croft on the west, the Meacham property—a Rogers-Brown operaton—is being put in shape by the installation of a new hoist and headframe. Considerable drilling is being done in the district. New drilling is about to be inaugurated on the Cuyuna Range Addition to the City of Brainerd, not many blocks distant from the city's business center.

TORONTO—Apr. 22

The Manitoba Government has sent M. J. K. Allen, an engineer, to the gold mining region lying to the northwest of Pas to report on the feasibility and cost of two portages which will make the district accessible by canoe route. Several companies are preparing to undertake development and an active mining season is anticipated.

Power for Kirkland Lake is assured as a result of a meeting, held in Toronto on Apr. 19, when it was voted to extend the transmission lines of the Northern Ontario Light and Power Co. from Cobalt to Kirkland Lake. The closing down of some of the Cobalt plants has given the company a surplus of about 5,000 hp., which will now be available for the mines farther north. The new line will pass through the Boston Creek and Sesikinika sections before it reaches Kirkland Lake. The decision of the power company to extend the lines is of great importance. At present the mines are using coal and wood for fuel, and find this very expensive. It is probable that power will be sold at from $50@60 per horsepower-year.

A Big Amalgamation may be made of the various properties held by the Canadian Mines and Finance Co., which is really the Timmins-McMartin syndicate. This company controls the Hollinger and owns outright the Acme and the Millerton companies as well as a few claims that are not included in these companies. It is proposed to form a new $30,000,000 company, to take over all the properties on the basis of 45% each for the Hollinger and the Acme and 10% for the Millerton and the other claims. The present shareholders of the Hollinger are to receive 4½ shares of the new company for each share of the present stock. The new company is to have 6,000,000 shares of $5 par. The proposed amalgamation will no doubt be advantageous, as it will permit of cheaper working costs and will assure a long life. The different properties have been developed with this end in view and it was only a case of selecting the most advantageous time.

To Foster the Zinc Industry, the Canadian government will offer a bounty for a short period after the war. Sir Thomas White, minister of finance, has given out the following: "That it is expedient to authorize the payment out of the consolidated revenue fund of a bounty of 2c. per lb. on zinc or spelter containing not more than 2% impurities, produced in Canada, from zinc ores mined in Canada, provided the standard price of zinc or spelter in London, England, at the time of production is less than £36 19s. 3d. sterling per ton of 2,240 lb., when the bounty payable shall be an amount equal to the difference between such standard price per ton and £36 19s. 3d. per ton; further provided that in no event shall bounty be payable when the price received for zinc by the producer is 8c. or more per lb. and that no bounty shall be payable on zinc to the producer during the continuation of the war, and in no event on zinc or spelter production after July 31, 1917." The total amount payable under the proposed act shall not exceed $400,000.

The Mining News

ALABAMA

GULF STATES STEEL CO. (Birmingham)—Contract has been let for new steel tipple at Shannon mine, near Oxmoor. This is a deep-mining operation.

ARIZONA

Gila County

ARIZONA COMMERCIAL (Globe)—Machinery for electric plant is to be delivered May 1.

COBB BROS. AND HILL (Gibson)—Report 2-ft. vein high-grade wulfenite; property adjoins Gibson mine.

ARIZONA ZINC AND LEAD (Miami)—New organization to work the Little Frank group, 15 mi. east of Globe, developed by 400-ft. tunnel and several prospect shafts. Officers are Frank Gassaway, president, R. H. Emery, vice-president, and Fay Hiatt, secretary-treasurer, all of Miami.

Mohave County

NELLIE (Oatman)—New machinery being installed; shaft down 90 ft. will continue to 400-ft. point.

BOUNDARY CONE (Oatman)—Shaft down 740 ft. and being deepened 4½ ft. a day.

FRANK MEREDITH (Hackberry)—Has struck 4-ft. vein 5% copper in 400-ft. adit on claims north of Hackberry.

BIG JIM (Oatman)—Crosscut on 485-ft. level cut vein at 110 ft. and at 135 ft. was still in the quartz. A. G. Keating, superintendent.

CASH ENTRY MINING (Oatman)—New subsidiary of Oatman Combination Mining Co., will develop Cash Entry claims. Machinery ordered.

OATMAN NORTH STAR (Oatman)—Hoisting plant installed; 70-ft. shaft sunk by hand will be continued to 500-ft. level; pannings from shaft show free gold.

MURDOCK EXTENSION (Oatman)—New mining corporation whose incorporators and stockholders are all women. Miss Kate Christy, of Phoenix, is treasurer, and Jeanne Maxwell and Anna Stevens are other incorporators.

OATMAN PIONEER (Oatman)—This property, formerly known as the German-American, 2 mi. from center of Oatman district, has opened an oreshoot on the 200-ft. level for a distance of 65 ft. Property optioned to Minor S. Keith and associates of Boston a few months ago. E. H. Dawson is manager.

Pinal County

RAY-HERCULES (Ray)—Plans for mill of 1,000 tons initial daily capacity, at Kelvin, 6 mi. south, being drawn by George Bradley. Mill designed to admit construction of additional units up to 5,000 tons daily. Twenty-nine drill holes already down indicate mineralized area may be wider than formerly expected.

Santa Cruz County

BURRO AND JOPLIN (Patagonia)—These groups bonded to J. E. Masters, who will erect 50-ton concentrator. Burro claims developed by 1,400-ft. shaft.

R. R. R. (Patagonia)—R. R. Richardson has sold this mine to the Harrison interests, formerly of Mexico, for $500,000. C. C. Sanders, mining engineer of Patagonia, who acted for the Harrisons, will manage the property. Development campaign will be instituted at once and a mill will be erected to treat low-grade ore not heretofore utilized.

Yavapai County

MONTEZUMA MINING (Crown King)—Erecting large sawmill to cut mine timber; camp will be rebuilt.

MIDDY (Mayer)—A 6-in. manganese vein opened in tunnel; first ever found in Bradshaw Mountain district.

NELSON (Crown King)—A tunnel in 3,200 ft. to connect deep working with surface outcrop, has milling-grade ore; production will begin as soon as connection is made.

RANDOLPH GEMMILL CO. (Crown King)—Treating daily over 100 tons of old Crown King dump; plans to increase capacity to 250 tons to take care of Nelson, War Eagle and Gladiator production.

Yuma County

ARIZONA-EMPIRE (Parker)—Freighting daily 3 carloads of ore to Parker; two new hoists will be installed; 20 men employed.

SWANSEA MINING (Swansea)—Shipping daily three carloads 4% copper ore to Humboldt smeltery; recently opened new orebody averaging 5% copper.

CALIFORNIA

Amador County

CHROMIC IRON ORE is being mined on the Courtright place, near Stony Creek. Stated that Ben Freguila and associates have contract to furnish a large tonnage.

PLYMOUTH CONSOLIDATED (Plymouth)—During year 1915, the 30-stamp mill treated 129,500 tons, average recovery $5.01, working costs $3.04 per ton; "middle chute," opened on 15th level, followed up to 950-ft. level; shaft sunk 300 ft. and levels opened at 2150, 2300 and 2450 ft.

Butte County

SOUTH BANNER (Oroville)—Reported that Richard Phillips, manager, contemplates installation of a mill about June or July.

CHROME DEPOSITS at Woodleaf, owned by Dickey & Driesbach, are being mined; contract has been awarded to Cluby & Johnson, of Oakland, for hauling 50,000 tons on motor trucks to Oroville for rail shipment. Reported that chromic iron has been disclosed near Pentz on property of John Marchant, of San Francisco.

Calaveras County

PIONEER (Angels Camp)—San Francisco men and Eastern men are reported to have option on Pioneer and the adjoining Morse and Rose properties and will develop on a large scale. Pioneer adjoins Gold Cliff, the leading producer of the Utica company. Shaft will be deepened to 1,000 ft. before levels are run.

Colusa County

RUBY KING (Maxwell)—Mine situated 2½ mi. northeast of Cook Springs has installed crushing machinery for experiment to determine whether ore can be economically and commercially prepared for manufacture of paint.

Inyo County

CERRO GORDO (Keeler)—Net earnings in five-month period ended Feb. 29, 1916, amounted to $40,260. Principal income was from zinc.

TUNGSTEN CLAIMS, 8 mi. west of Bishop, are proving of sufficient interest to induce road improvements. L. E. Stevens, of Kingman, Ariz., and F. M. Townsend controlling the group of claims, formerly owned by Nobles, Cooper and Powing, contemplate 200-ton mill.

MANGANESE (Owl Holes)—Ore being hauled from point known as Owl Holes to Riggs on Tonopah & Tidewater R.R., 57 mi. north of Ludlow. Hauling done by Frank A. Campbell with Yuba ball-tread tractor moving 14 tons to each load and requiring 36 hr. for round trip of 78 mi.

BIG PINE DISTRICT is attracting attention of prospectors who claim to have discovered deposits of copper, silver, tungsten and lead. Town practically deserted, the population being in the hills prospecting. Discoveries in Loretta and Waucoba sections, east of Big Pine, reported.

Napa County

RUTHERFORD MINING CO. (Rutherford)—Granted permission by the Corporation Commission to sell 19,000 shares at 75c. per share to install plant.

Nevada County

PROVIDENCE (Nevada City)—Central shaft has reached 2,000 ft. Champion, River City and Home will be developed through this shaft, which is to continue to 3,000 ft.

MOUNTAINEER (Nevada City)—The 10-stamp mill, compressor and part of tramway, destroyed by fire Mar. 13. F. J. Sloat and the Benders, of Hamilton, Ohio, owners. Loss over $10,000; no insurance.

BRUNSWICK (Grass Valley)—The 40-stamp mill running regularly, crushing about 3,300 tons of ore per month. Operating cost reduced from $8.45 to $6.78 per ton.

GRASS VALLEY CONSOLIDATED GOLD MINES (Grass Valley)—New incorporation to succeed the Gold Center. An electric hoist, 20-stamp mill, a tube mill and further sinking are contemplated. C. A. Brockington, superintendent.

Plumas County

ENGELS (Keddie)—Lower tunnel started to tap orebodies at 750 ft., 350 ft. below present deepest level.

WALKER (Portola)—Machinery is arriving for flotation plant in Grizzly Valley, 4 mi. by wagon road from the mine. Tramway will be installed.

Shasta County

AFTERTHOUGHT (Ingot)—Supt. John W. Bull has started retimbering old tunnels and resuming work on important scale.

Sierra County

MONARCH AND CLEVELAND (Sierra City)—Additonal power plant and sawmill to be installed and lower tunnel to be driven. R. G. Gillespie and D. McGonigal, operators.

COLORADO

Clear Creek County

FRENCH FLAG (Idaho Springs)—A 45-ton mill is contemplated. C. H. Ripley, manager.

SILVER KING (Dumont)—New mill to be built by Hendrie & Bolthoff Mfg. and Supply Co., of Denver.

BELLEVUE-HUDSON (Idaho Springs)—Rich strike made by Geisecke & Co., leasing on Bellevue vein 1,000 ft. from portal of Rochester tunnel on 14th level. Vein 2 ft. wide.

DOCTOR TOWN (Empire)—This property in Daily district being developed by Argo Leasing Co., Albert Hanson, resident manager. Ore in adit contains pyrite, galena and sphalerite. Mill is contemplated.

COLORADO CENTRAL LEASING CO. (Georgetown)—Dumps on Leavenworth Mountain being sampled to determine best method of treatment. Erection of a mill is under advisement. E. S. Wiard and G. Kyner are in charge.

Boulder County

MAZDA TUNGSTEN (Boulder)—Company incorporated to acquire seven Tungsten Mountain properties. Matthew Moyle is superintendent.

RARE METALS CO. (Rollinsville)—Sampling and tungsten-concentrating plant will be built by Colorado Iron Works Co., of Denver. Raymond Akins, engineer in charge of construction.

Lake County

HARVARD (Leadville)—The sinking pump being used at this shaft was manufactured by the Byron Jackson Iron Works, of San Francisco, and is not, as previously stated, a Krogh deep-well pump.

San Juan County

ADAMS (Gladstone)—Gilhaney & Oleson, lessees, have opened 6-ft. vein of quartz banded with hübnerite.

RUBY (Silverton)—Recent development, in Maggie Gulch, disclosed a vein of hübnerite ore, 4 to 6 ft. wide. E. J. Holman & Co. have option on the property.

KITTEMAC (Silverton)—Mill, remodeled to include Huff electrostatic separation, has started treating ore mined years ago. Aërial tram being repaired; mine development resumed.

San Miguel County

OPHIR SUPERIOR MINING CO. (Ophir)—S. E. Smith appointed superintendent. Development on Calumet will be resumed.

CARIBEAU (Ophir)—Old stopes, now being sampled by Charles Hockin, may be treated by flotation. George L. Bingham is manager.

Summit County

WELLINGTON (Breckenridge)—Apr. 1 wages of all employees increased 35c. per day, dependent on price of spelter.

Teller County

UNITED GOLD MINES CO. (Victor)—In Trail property, southwestern slope of Bull Hill, a 10-in. vein of 3-oz. gold ore has been opened by J. L. Wilson.

VINDICATOR (Independence)—Last two Golden Cycle purchase notes called Apr. 19. Entire Golden Cycle mine paid for out of profits in less than 14 months, without interfering with dividends.

JERRY JOHNSON (Cripple Creek)—The oreshoot on 850-ft. level of main shaft has been opened for 70 ft. Vein 4 to 6 ft. wide and averages $25. Mine now being developed by Cripple Creek Deep Leasing Co.; one-half interest held by the Milltown Extension Gold Mining Co.

IDAHO

Shoshone County

INTERSTATE-CALLAHAN (Wallace)—Reported that new mill of large capacity will be built on a site near Enaville.

HECLA (Burke)—At annual meeting, report showed profit for 1915 of $561,751 from production of 692,444 oz. of silver and 24,917,867 lb. of lead. One ton of ore or concentrates was shipped for each 5.6 tons of material mined.

CASTLE ROCK (Wallace)—Work resumed after suspension of over three months caused by snowslides. Drifts east and west from 200-ft. shaft show vein of copper ore of good grade. Mine now being developed by Idaho-Nevada Exploration Co.

NATIONAL (Mullan)—Profit $8,000 is understood to have been made in March, with mill running only one shift. Mill is 1½ mi. from mine, connected by electric tram; motive power capable of delivering ore for only one shift. More powerful motors ordered and on arrival mill will operate full time.

MICHIGAN

Copper

FRANKLIN (Demmon)—Wolverine sandstone cut and crosscut driven through Kearsarge formation.

SENECA (Calumet)—Development plans call for sinking two pairs of shafts. First pair to be sunk at once in northeast quarter of Section 28 near No. 2 Mohawk shaft; second pair sunk later in southwest quarter of Section 22.

KEWEENAW (Mandan)—Shaft sunk to 1,600 ft. point, made 14th level. On sixth level development drift shows 20 ft. width reported to assay nearly 2% copper along foot wall. Total of 1,900 ft. of drift on this level in good ore.

Iron

RICHMOND (Palmer)—Operations have been started at this mine.

SOUTH JACKSON (Negaunee)—This openpit mine reopened with about 75 men.

REPUBLIC (Republic)—First Marquette range property to start loading from stockpile.

SECTION 6 (Ishpeming)—Stripping is almost completed. Shovel is down to the ore in places.

CHAPIN (Iron Mountain)—Two shovels are loading from stockpile for shipment to Escanaba docks.

DETROIT IRON AND STEEL CO. (Detroit)—Contemplate building a third blast furnace at Zug Island plant.

MINNESOTA

Cuyuna Range

ROWE (Riverton)—Work of installing jigs in concentrating plant progressing. Two shovels working in the pit.

TABERT (Brainerd)—Shaft down 60 ft. About 1,000 gal. water per min. being handled.

Mesabi Range

CROSBY (Nashwauk)—Mill started Apr. 20; constructed last autumn and had satisfactory test early this year.

TIOGA (Chisholm)—Development work is being rushed. Some drifts have reached ore and shipments will soon be started.

MAHONING (Hibbing)—Expects to ship 2,900,000 tons this year. Four or five shovels will be at this work; one shovel at present stripping.

HARTLEY-BURT (Chisholm)—Man killed Apr. 14 while engaged in test-pitting. Fastening of bucket of ore on cable gave way, dropping bucket on miner's head.

NORTH EDDY (Hibbing)—Underground property of Tod-Stambaugh interests developed last summer. Billings underground-loading machine in operation. Shipping about 600 tons a day.

COLERAINE is becoming active. Four shovels are stripping at the Canisteo on two shifts. Two shovels are stripping at the Holman and the Arcturus is employing three shovels day and night.

HARRISON (Nashwauk)—Six shovels are set up for summer's work, including a big Bucyrus of revolving type, with 6-cu.yd. dipper, for casting overburden on bank—only shovel of type on the range.

OLIVER (Buhl)—The Wanless and Shiras mines are being equipped underground for electric haulage. Engine houses being enlarged to make room for electric equipment. Electric-driven compressor installed at the Alpena.

Vermilion Range

SOUTH CHANDLER (Ely)—Miner crushed to death by cave-in on 13th level, Apr. 15.

McCOMBER (Ely)—Pumping station has been cut on the 100 level; No. 9 Fairbanks-Morse and No. 9 Cameron pump installed. Officials report 20-ft. vein of hematite of Bessemer grade. Planned to sink to the 300 level.

MISSOURI

Joplin District

BABCOCK (Joplin)—This 200-ton mill north of Joplin is being completed. Steam power used. Mining at two levels, 145 and 170 ft., in soft ground.

J. A. T. MINING CO. (Joplin)—The new mill on Snapp land north of Joplin is producing about 45 tons of concentrates a week although ground is not yet well opened. Soft ground being worked at a depth of from 159 to 180 ft.

CHAPMAN BROS. & LONGACRE (Webb City)—Erecting a 500-ton mill at their mine north of Webb City. Completed plant will cost $80,000, and will include condensing Corliss engines and two compressors. There are three shafts already sunk into ore, the formation being typical sheet ground.

Madison County

MADISON MINING CORPORATION (Fredericktown)—This new company has taken the old silver mine, and adjoining property of A. H. Handlan, and will operate it for tungsten, wolframite occurring in a quartz vein. This old mine, operated many years ago for silver, is 8 mi. west of Fredericktown, near the St. Francois River, on road to Ironton. Concentrator may be erected. H. W. Edmondson is manager.

MONTANA

Broadwater County

THREE FORKS COPPER MINING CO. (Three Forks)—Sinking shaft in Emerson district recently opened 4-ft. vein of copper ore at 350 ft.

Fergus County

HANOVER GYPSUM CO. (Lewistown)—The 7-mi. spur to property has been completed by Great Northern Ry. and power line is being run by Montana Power Co. First shipments of gypsum will go to Bellingham, Wash.

Granite County

ALGONQUIN (Phillipsburg)—A test shipment of 50 tons of manganese ore has been made to the Eastern market.

Jefferson County

MOUNT THOMPSON (Basin)—Tunnel driven 1,000 ft. on vein and much low-grade ore opened. A gasoline engine, compressor and machine drills recently purchased. Mill contemplated.

Lincoln County

BANNER AND BANGLE (Troy)—Definitely taken over from the Greenough Estate by Snowstorm Mining Co. Reported capitalization will be increased from $1,500,000 to $2,000,000 to finance new venture and remove mill from Larsen to Troy, build hydro-electric plant and railroad to mine.

Madison County

MOFFIT (Twin Bridges)—Copper ore being shipped to Butte for treatment. Mine now operated by Mines Development Co. of Butte.

AJAX (Rochester)—Pittsburg capitalists completed negotiations for leasing this old silver-lead mine. Property will be unwatered, retimbered and new hoisting plant and machinery installed.

Missoula County

INTERMOUNTAIN (Superior)—Preparations being made by Wallace, Ida., men to operate this property, formerly the Amador. Mining will shortly commence on 200- and 400-ft. levels. A 100-ton mill constructed last summer.

Silver Bow County

DAVIS-DALY (Butte)—Orebody on 2,500-ft. level opened for 400 ft., showing average 8-ft. width assaying 6% copper.

BUTTE-DETROIT (Butte)—Work started on the Ophir mine preliminary to a resumption of operations.

ANACONDA (Butte)—Drifting started on the 500 level of old Nettie silver mine; so far no rich ore has been found.

PILOT-BUTTE (Butte)—Stockholders will receive $12.27 on final distribution of assets. Including the $1,125,000 received from Anaconda company for the Pilot mine, there is for distribution a total of $1,130,554.

GREAT BUTTE COPPER CO. (Butte)—This company is being organized to acquire assets of the Butte & Bacorn company on basis of 1 for 10 shares and rights to additional new stock at 66c. per share.

NEVADA

Storey County

HALE & NORCROSS (Virginia)—Reopening of tunnel continued.

UNION (Virginia)—Shaft reopened to 340 ft. below 2,000 level.

OPHIR (Virginia)—Saved 40 tons of ore, averaging $25, on 2,450 level. Drifting on east vein.

SIERRA NEVADA (Virginia)—Extracted 101 tons, averaging $19, from No. 1 stope, 2,500 level.

UNION CON. (Virginia)—Extracted 298 tons; total value, over $6,000. North drift 2,700 level reopened to 250-ft. point.

CROWN POINT-BELCHER (Gold Hill)—Extracted from stope No. 3, 1,600 level, 350 cars of ore. Jacket mill received 375 tons mine ore and 531 tons dump rock.

MEXICAN (Virginia)—West crosscut, 2,500 level, in second-vein formation of main Comstock lode. East crosscut 2,700 level in porphyry and quartz, low assay. Mill crushed 475 tons custom ore.

NEW MEXICO

Grant County

BURRO MOUNTAIN (Tyrone)—First unit of new 1,000-ton mill started on Apr. 15.

SILVER CELL (Pinos Altos)—Streak of 50% silver ore in vein on 350-ft. level: P. de la Pena, mining man and former governor of the state of Coahuila, Mexico, has bought 200,000-share interest.

NEW YORK

Sullivan County

ST. NICHOLAS ZINC (Summitville)—Mine reported optioned to New York syndicate and operation expected soon. Situated on the Ontario and Western R.R. between Summitville and Mamakating. Upper workings and dump carry considerable lead; 1,100-ft. tunnel cuts vein at foot of mountain.

OREGON

Baker County

COUGAR (Sumpter)—Taken over on 18 months' lease and bond for $300,000 by recently organized United Gold Mining Co. Cyanide plant and additional tube mills ordered for old mill and 25 men will be put at work upon arrival. E. C. Brain, formerly of Helena, Mont., general manager.

SOUTH DAKOTA

Lawrence County

REPUBLIC (Deadwood)—Sol Burns and John Sanford, of Maitland, have lease on Blaine tunnel. Milling ore will soon be shipped.

WELLS FARGO (Deadwood)—Lessees of this Golden Reward property are dewatering Imperial shaft on Blacktail gulch to drain Wells Fargo.

WASP NO. 2 (Flatiron)—Payment of 5c. dividend on Apr. 15 makes total this year, realized from tungsten mining, 17½c. per share, or $85,000. Mill running steadily. Last shipment consisted of 23 tons mixed grades, from 34 to 60% tungstic acid, sold for a level price of $82 per unit.

ORO HONDO (Deadwood)—In application before state engineer for authority to divert water of Whitewood for milling and other purposes, Oro Hondo was given permission to use all water in excess of that owned or appropriated by prior claimants. Shaft is now 2,000 ft. deep; results of development are not announced but understood to be highly satisfactory.

RATTLESNAKE JACK (Galena)—Milling suspended pending adjustment of differences between owners, C. B. Harris, of Galena, and William Sansom, of New York, regarding Sunday claim, belonging solely to Harris. Meantime six men are employed underground. Property in last few months has produced some exceptionally rich ore, while mill has been treating 60 tons daily of $15 to $20 material.

HOMESTAKE (Lead)—Installation is being made of concentrating equipment for treatment of tungsten ores. Plant, which will have capacity of about 20 tons daily, will contain five stamps, Wilfley and Deister tables. Ore will be crushed at Star shaft, thence carried on picking belt about 100 ft. to stamps. High-grade ore will be hand-picked from this belt. Golden Summit claim has produced nearly 100 tons of shipping ore during last winter and much greater amount of mill rock has accumulated.

Pennington County

TUNGSTEN MINING IS BOOMING at Hill City; Black Hills Tungsten Co. is employing 30 men in mine and mill and making regular shipments; Black Metal leased to aggressive operators and numerous claim owners are working their own properties. Wolframite has recently been discovered in the pegmatites and has resulted in renewed activity over a large area.

TENNESSEE

Polk County

TENNESSEE COPPER (Ducktown)—Has resumed shipments of sulphuric acid on contract with International Agricultural Corporation. The 1915 acid production was 210,666 tons; copper, 12,750,418 lb.; expended on new construction, $1,006,843; net profit, $1,058,158 Ore reserves at end of year 5,087,421 tons, not counting ore indicated by diamond drilling below eighth level.

UTAH

Beaver County

KING DAVID (Frisco)—May resume development on this property adjoining the Horn Silver; 309,854 treasury shares to be sold.

COMMONWEALTH (Milford)—Work to be resumed. Ore carrying copper, silver and an excess of iron opened on Beaver claim. Strevell, Paterson and Bradley of Salt Lake are interested.

MONTREAL (Milford)—From 12 to 15 cars monthly of low-grade copper ore being obtained near contact of limestone with monzonite porphyry in the Rocky district.

Juab County

TINTIC SHIPMENTS for week ended Apr. 15 totaled 171 carloads valued at $210,000 from 23 shippers.

IRON BLOSSOM (Silver City)—Drift on 1,100 level followed copper vein for 80 ft. Winze will be sunk another 100 ft.

TINTIC STANDARD (Eureka)—Teams started hauling ore 5 mi. to Iron Spur. Three cars ready for shipment. Ore opened near 1,500 level.

SIOUX CONSOLIDATED (Eureka)—After several years inactivity, the company will try to develop the continuation of Iron Blossom copper deposit.

PLUTUS (Eureka)—At a special directors' meeting decided to begin development at once. Walter Fitch elected member of the board; Jesse Knight is president; David Evans vice-president and general manager.

Salt Lake County

SILVER SHIELD (Bingham)—Raise in the new lead-silver orebody for 35 ft., has shown ore to be from 39 to 45 in. thick. One car shipped.

HOWELL (Salt Lake)—Controlling interest in this Big Cottonwood property, adjoining the Cardiff, secured by Ezra Thompson and J. C. Lynch of Cardiff company.

Utah County

AMERICAN FORK is becoming active. Snow melting rapidly, and ore hauling will soon begin. Mining or development being done at the Pacific, Earl-Eagle, Bellerophon, Bay State, Alpine, Empire, Wasatch Range and other properties.

WASHINGTON

Stevens County

NORTHPORT SMELTING AND REFINING (Northport)—Third lead furnace of 300 tons daily capacity being erected.

BLUE STAR (Chewelah)—Ground slide into old upraise last winter exposed extensive shoot high-grade lead-silver ore. Property bonded by E. M. Keough and U. T. McCurry. Will ship ore soon; 20 tons already sacked.

WISCONSIN

Platteville District

BELL (Platteville)—This new company constructing 50-ton mill on the Bell land.

MAPLE GLEN (Platteville)—Ore proved on Linden farm, 3 mi. southwest of Platteville; sinking shaft.

SHULLSBURG-FAIRPLAY (Shullsburg)—J. P. Wherry and others have taken over this property on the Fred Howe land and are erecting 50-ton mill.

CANADA

British Columbia

FLORENCE SILVER (Ainsworth)—Will construct 200-ton concentrator at property on Kootenay Lake, also hydro-electric power station and aërial tram; Ferdinand R. Wolfle, of Spokane, president and manager.

CONSOLIDATED MINING AND SMELTING (Trail)—Construction of a plant for production of sulphuric and hydrofluoric acid has been started. First unit of electrolytic zinc refinery in operation. Copper refinery contemplated.

Ontario

KERR LAKE (Cobalt)—March production of 214,920 oz., highest for several years.

DOME EXTENSION (Porcupine)—Shareholders ratified agreement giving Dome Mines an option.

NORTH THOMPSON (Porcupine)—Shaft being continued to 500-ft. level. Mill is contemplated.

VIPOND (Porcupine)—The Davidson vein encountered on 500-ft. level, where it is about 13 ft. wide.

TIP TOP (Kashabowie)—This mine shipped 350 tons of copper ore to the smelters, the first shipment for several years.

ADANAC (Cobalt)—High-grade ore found below 200-ft. level. Company which owns 60 acres adjoining Temiskaming is offering 250,000 shares at 50c.

LAKE SHORE (Kirkland Lake)—A 6-in. vein of high-grade ore with 7 ft. of milling ore has been cut at the 300-ft. level. New compressor will be installed.

CROESUS (Munroe)—Considering installation of small mill. Ore above 200-ft. level assays about $500 for a width of 20 in.; vein on 300-ft. level not so rich. Company obtained $40,000 from 800 lb. of quartz while sinking shaft.

HOLLINGER (Porcupine)—The 4-weekly statement for the period ended Mar. 24 shows gross profits of $151,302, from the treatment of 28,712 tons of ore of the average value of $9.04 per ton at a working cost of $3.32 per ton. In addition 12,781 tons of Acme ore were treated.

AUSTRALIA

ASSOCIATED SMELTERS (Port Pirie, S. A.)—Acting Attorney General Mahon announced on Mar. 31 that all Broken Hill producers, except Sulphide Corporation, which has its own smelting plant, had joined in Associated project to smelt, refine and sell their concentrates for period of 50 years.

CHOSEN

ORIENTAL CONSOLIDATED (Unsan)—February product of $118,157 made by 200 stamps running 28 days, crushing 24,675 tons.

CHINA

EXTENSIVE IRON DEPOSITS reported at Laiwusien, Shantung Province, about 30 mi. east of railroad. Estimates from hasty survey indicated possibility of 200,000,000 tons of ore.

DUTCH EAST INDIES

BIDS FOR A GOLD-MINING PLANT on the Island of Sumatra will shortly be asked from American and British manufacturers by the Dutch government, according to a cable from the Hague.

The Market Report

Metal Markets

NEW YORK—Apr. 26

During the last week copper became significantly stronger, but all of the other metals were weaker, the prices receding on relatively light business.

Copper, Tin, Lead and Zinc

Copper—During the early part of our week of record, the business in copper was relatively light, at unchanged prices, but on Tuesday some business of major character was transacted at an advance. Producers are now so generally sold out, and consumers are so well covered, that the principal market is for delivery in July and later. Near-by deliveries command a stiff premium, but there is neither much copper for sale nor much demand for it. Agencies that are able to supply near-by copper were sellers at the end of the week on the following scale: April, 30c.; May, 29¾c.; June, 29¼c.; July, 28¾@29.; August, 28½@28¾; September, 28½; October, 28¼; November, 28⅛; December, 28; all regular terms. The business transacted during the last week was chiefly with domestic consumers.

The average difference between the gross price and the net price for copper in 1915, based on the sale of a large part of the output, was 0.32c. per lb., i.e., the sale of copper on "regular terms" netted 0.32c. per lb. less in cash, New York.

Copper Exports from Baltimore for the week were 2,790,545 lb. to Great Britain and 1,120,138 lb. to France.

Copper Sheets, base price, is 36½c. per lb. for hot rolled and 37½c. for cold rolled. Usual extras charged and higher price for small quantities. Copper wire is 32½@33c. per lb. for large lots at mill.

Tin—Up to Tuesday the market was dull. On Tuesday a good business was reported transacted, chiefly in futures. The market exhibited no features of special interest.

Exports of tin concentrates from Bolivia to the United States were first made in noticeable quantity in 1915, when there were 1,875 metric tons, estimated to contain 1,132 tons metallic tin. For the three months ended Mar. 31, 1916, the exports were 1,521 tons concentrates, containing 898 tons tin.

Lead—The principal producers reported a fair business done from day to day in relatively small lots. Everybody came down to the price of the principal producer, and the St. Louis market returned to proper tune with the New York market.

Spelter—But very little domestic business was reported. Some round lots were sold for export, for such deliveries as June-August and June-September. The bulk of this business was taken at 15¾@16c. On Wednesday there were sellers as follows: May, 17c.; June, 16½c.; third quarter, 15½c.; fourth quarter, 14c. It was rumored, however, that certain interests were trying to sell fourth-quarter delivery at 13½ cents.

Receipts at Baltimore for the week included 9,845 tons zinc ore from Spain.

Zinc Sheets continue active with good sales. Quotations have advanced slightly and the base price is now $25.50 per 100 lb., f.o.b. Peru, Ill., less 8% discount.

Other Metals

NEW YORK—Apr. 26

Aluminum—Business has been quite steady, with fair demand. Deliveries on contract are good. The market is still inclined to be easy, with quotations at 58@60c. per lb. for No. 1 ingots, New York.

Antimony—Spot and near-by is quoted at 39@40½c. per lb. with the market somewhat erratic after a week of stagnation. Shipment from China within one month is quoted 32½@33½c. per lb., c. i. f., New York, duty unpaid.

Quicksilver—Business is moderate and buyers seem to be holding back. Stocks in the East are good, and buyers apparently are hoping for further reductions. New York quotations are $120@125 per flask of 75 lb. It is said that these quotations have been shaded, and a sale is reported as low as $106 per flask. San Francisco reports by telegraph $125@130 per flask, with a very quiet market.

Nickel—Business is steady and prices unchanged. Ordinary forms are 45@50c. per lb., according to size and terms of order. Electrolytic nickel is 5c. per lb. higher.

DAILY PRICES OF METALS IN NEW YORK

Apr.	Sterling Exchange	Silver, Cts. per Oz.	Copper	Tin	Lead		Zinc
			Electrolytic, Cts. per Lb.	Spot, Cts. per Lb.	New York, Cts. per Lb.	St. Louis, Cts. per Lb.	St. Louis, Cts. per Lb.
20	4.7650	65⅛	28 @28¼	50	7.50 @7.55	7.40 @7.50	15.25 @17.25
21	4.7650	65⅛	28 @28¼	50	7.50 @7.55	7.37½ @7.42½	15.25 @17.25
22	4.7650	65⅛	28 @28¼	50	7.50 @7.55	7.37½ @7.42½	15.25 @17.00
24	4.7650	65⅛	28 @28¼	49¾	7.50	7.37½ @7.42½	15.25 @17.00
25	4.7650	67⅛	28¼ @29	49½	7.50	7.37½ @7.42½	15.25 @16.75
26	4.7650	67⅛	28½ @29	49½	7.50	7.37½ @7.42½	15.25 @16.50

The quotations herein are our appraisal of the average markets for copper, lead, spelter and tin based on wholesale contracts for the ordinary deliveries of the trade as made by producers and agencies; and represent, to the best of our judgment, the prevailing values of the metals, reduced to basis of New York, cash, except where St. Louis is given as the basing point. St. Louis and New York are normally quoted 0.17c. apart.

The quotations for electrolytic copper are for cakes, ingots and wirebars. Electrolytic copper is commonly sold at prices including delivery to the consumers and is subject to discounts, etc. The price quoted for copper on "regular terms" is the gross price including freight to the buyer's works and is subject to a discount for cash. The difference between the price delivered and the New York cash equivalent is at present about 0.25c. on domestic business. The price of electrolytic cathodes is 0.05 to 0.10c. below that of electrolytic. Quotations for lead represent wholesale transactions in the open market for good ordinary brands. Quotations for spelter are for ordinary Prime Western brands. Only the St. Louis price is herein quoted, St. Louis being the basing market. We quote the New York price at 17c. per 100 lb. above the St. Louis price.

Silver quotations are as reported by Handy & Harman and are in cents per troy ounce of fine silver.

Some current freight rates on metals per 100 lb. are: St. Louis-New York 17c.; St. Louis-Chicago, 6.3c.; St. Louis-Pittsburgh, 13.1c.

LONDON

Apr.	Silver	Copper				Tin		Lead		Zinc	
		Standard		Electrolytic							
		Spot	3 Mos.	£ per Ton	Cts. per Lb.	Spot	3 Mos.	£ per Ton	Cts. per Lb.	£ per Ton	Cts. per Lb.
20	31 1/16	131	124	140	29.81	198½	196½	34½	7.37	103	21.93
21	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
22	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
24	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
25	32	131	124	140	29.81	198	196	34	7.24	103	21.93
26	32 1/16	132	125	140	29.81	198½	196	34½	7.35	103	21.93

The above table gives the closing quotations on London Metal Exchange. All prices are in pounds sterling per ton of 2240 lb., except silver which is in pence per troy ounce of sterling silver, 0.925 fine. Copper quotations are for standard copper, spot and three months, and for electrolytic, price for the latter being subject to 3 per cent. discount. For convenience in comparison of London prices in pounds sterling per 2240 lb., with American prices in cents per pound the following approximate ratios are given, reckoning exchange at 4.80. £15 = 3.21c.; £20 = 4.29c.; £30 = 6.43c.; £40 = 8.57c.; £60 = 12.85c. Variations, £1 = 0.21⅜c.

Gold, Silver and Platinum

NEW YORK—Apr. 26

Transvaal Gold Production in March was 796,689 oz., or $16,467,562; being 43,105 oz. more than in February, and 42,754 oz. more than in March, 1915. For the three months ended Mar. 31 the total production was $48,325,013, being $8,281,249 more than in the first quarter of last year.

Platinum—The market remains quiet and without material change. Transactions are of a small order. Sales have been made at $80@86 per oz. for refined platinum. Hard metal is quoted about $5 per oz. higher.

Silver—The market, owing to the Easter holidays, has been inactive most of the week, but on the reopening of the London market on Apr. 25 it experienced a very sharp advance to 32d. This rise is due to limited supplies and urgent demand from England and the Continent for coinage. Large shipments have been made from China to India on account of the Indian Government so that silver stocks have been greatly reduced in China, and the possibility of China selling freely eliminated. Russia has also taken about 5,000,000 oz. from China for coinage, and it is reported that Russia needs more silver. The disturbances in Mexico continue to affect the production of silver seriously. The stock of silver in London is small, about £600,000, and while the market closes quieter at 32 1/16d. the tendency continues firm with higher prices probable.

Zinc and Lead Ore Markets

JOPLIN, MO.—Apr. 22

Blende, high price, $122.25; per ton 60% zinc, premium ore, $120; medium grades, $115@105; lower grades, down to $100; calamine, per ton 40% zinc, $85@75; average selling price, all grades of zinc, $112.72 per ton. Lead, high price, $105.10, per ton 80% metal content, $102@100; average selling price, all grades of lead, $93.39 per ton.

SHIPMENTS WEEK ENDED APR. 22.

	Blende	Calamine	Lead	Values
Totals this week..	18,817,710	948,600	2,667,330	$1,238,550
Totals this year...	229,020,280	20,317,770	37,506,050	$15,228,610

Blende value, the week, $1,075,180; 16 weeks, $12,788,650.

Calamine value, the week, $38,830; 16 weeks, $762,490.

Lead value, the week, $124,540; 16 weeks, $1,676,870.

The zinc-ore production of this week is estimated at 10,000 tons. Buyers, following the weaker tone of spelter, and the lighter demand for ore, dropped price offerings $5 on premium to $10 on medium grades of zinc blende, while calamine was $5 lower. The shipment of 9,880 tons would leave but a slight increase to the stock in the bins, most of which, except some withheld this week, is sold for immediate delivery. A Stott City mine made a carload sale of blende this week, the first for several years. Greenfield is producing considerable calamine and Ash Grove produces about two carloads of calamine monthly.

PLATTEVILLE, WIS.—Apr. 23

The base price paid this week for 60% zinc ore was $112@115 per ton. The base price paid this week for 80% lead ore was $95@98 per ton.

SHIPMENTS WEEK ENDED APR. 23

	Zinc ore, lb.	Lead ore, lb.	Sulphur ore, lb.
Week	3,464,000	472,900	943,600
Year	66,180,000	2,252,910	16,700,200

Shipped during week to separating plants, 5,936,000 lb. zinc ore.

OTHER ORES

Pyrites—Receipts at Baltimore for the week included 8,084 tons iron pyrites from Huelva, Spain.

Manganese Ore—Imports of manganese ore in the United States in February are reported by the Department of Commerce at 8,685 gross tons. For the two months ended Feb. 29 the imports were 9,876 tons in 1915, and 25,333 tons in 1916; increase, 15,457 tons.

Antimony Ore—Demand continues subject to ocean-freight difficulties from South America. Ore afloat has been sold during the week at $2.75 per unit.

Tungsten Ore—Quotations have declined sharply again. The increased activity in this country and South America stimulated by the very high prices is bringing out large supplies. Actual sales for immediate delivery have been made as low as $70 per unit. Most consumers have contracted for their immediate requirements and futures can be sold only at a discount which holders are not willing to concede. The break will probably eliminate a good many speculators.

Iron Trade Review

NEW YORK—Apr. 26

The iron and steel markets show no material change. The demand for export is unabated, notwithstanding recent intimations of a falling off, and domestic orders are steady and pressing. The mills generally are full and early deliveries are quite out of the question. This condition will apparently continue through the year.

Exports from Baltimore for the week included 3,689,970 lb. steel billets, 2,435,979 lb. steel skelp, 3,501,260 lb. bars and wire rods and 992,532 lb. tinplates to Great Britain.

The United States Steel Corporation makes the following statement for the quarter ended Mar. 31, the net earnings including surplus over working expenses, ordinary repairs and renewals:

Net earnings:	1915	1916
January	$1,687,150	$18,794,912
February	3,638,578	19,196,396
March	7,132,081	22,722,316
Total	$12,457,809	$60,713,624
Depreciation and renewal funds		$7,859,253
Interest and sinking funds		7,080,499
Premium on bonds redeemed		261,000
Total charges		$15,200,752
Surplus for quarter		$45,512,872

From this surplus is to be deducted $6,304,919 for dividend on preferred stock and $6,353,181 for 1¼% dividend on common stock, leaving $32,854,172 balance. The net earnings for the quarter were the largest ever reported.

PITTSBURGH—Apr. 25

Following the wage-advance announcements by the three large independents at Youngstown, Apr. 15, and by the Steel Corporation Apr. 18, as noted in last report, nearly all the other iron and steel interests have announced advances, to become effective May 1, and averaging fully 10%. Whether this advance, following the advance of slightly more than 10% on Feb. 1, will settle wage matters in the iron and steel industry for the rest of the year, is open to question. Labor is extremely restive. The strike of Pittsburgh molders inaugurated Dec. 13 is not settled, and the employers seem to have lost ground in the past fortnight. A general strike of machinists in the Pittsburgh district is threatened, for full pay for eight hours' work, on the basis that the men will work more than eight hours, but will secure overtime rates for the additional time. Employees of the Westinghouse Electric and Manufacturing Co. have already gone on strike for this basis. In a published signed statement the great majority of the machinery makers of the district have stated positively they will grant no such demand. The employees of the Pittsburgh Coal Co. and one or two independents went on strike yesterday morning, claiming the McAlpin agreement has been wrongly interpreted, but the operators claim they are supported by the miners' national officials and that the matter will be settled within a few days. Recurrent and perhaps very serious labor troubles are expected as long as industrial conditions remain as at present.

Specifications against steel contracts continue heavy, but strictly new buying is further reduced and is now at a low rate. Such quietness is natural when business has already been done so far ahead The tonnage of prompt material inquired for is not large, but is sufficient to maintain premiums previously obtained for prompt shipment, and even to increase them.

While the steel mills reached nominally full operations last September they continue to break many records, and the output is now larger than at any time.

FERROALLOYS

Ferrosilicon is still quoted at $83@85 at furnace, but there is practically none available for early delivery. As high as $90 per ton at seaboard has been paid for prompt shipment.

Spiegeleisen is quoted at $70@75 at furnace for 20% manganese for early delivery.

Ferromanganese—There is only a moderate tonnage of English now available for the first half of 1917, at the regular price of $175. Spot continues to be quotable at $400 when it can be found and a few sales have been made at this figure and slightly higher.

Two additional furnaces have been put on ferromanganese. These are No. 2 Colebrook, of the Lackawanna Steel Co., and No. 2 Dunbar, of the American Manganese Co. The net gain is only one stack, however, as No. 1 Dunbar has gone out for repairs and relining.

IRON ORE

Opening of navigation on the Lakes is slow. The port of Escanaba is open and the first cargo was taken from there by the "Willis L. King." Ice at the Sault in still heavy and the first boats are not likely to pass before May 1. Shipments of ore this season will be limited by the bottoms to be had. So many boats have already been chartered that there are few now available, and they are asking high rates. The opening is further delayed this week by very stormy weather on the Lakes.

COKE

Coke production in the Connellsville region for the week is reported by the "Courier" at 462,920 net tons; shipments, 454,395 tons. Shipments of Greensburg and Upper Connellsville districts were 39,523 tons.

Assessments

Company	Delinq.	Sale	Amt.
Andes, Nev.	May 9	May 31	$0.02
Benton, Ida.	Apr. 15	May 15	0.005
Black Jack, Utah.	Apr. 11	Apr. 29	0.01
Bonanza, Utah.	Apr. 18	May 18	0.03
Dennemora, Ida.	Apr. 5	May 15	0.002
Diam'dfield Black Butte, Nev.	Apr. 12	May 18	0.01
Dugway, Utah.	Apr. 24	May 15	0.0033
East Hercules, Ida.	May 1	June 1	0.0015
Echo, Ida.	Apr. 14	May 15	0.002
Elise, Utah.	Apr. 12	May 18	0.0025
Emerald, Utah.	Apr. 15	May 13	0.0033
Emerald, Utah.	May 15	June 10	0.0033
Emerald, Utah.	June 15	July 8	0.0033
Federal Ely, Nev.	May 1	June 4	0.005
Friend, Ida.	Apr. 28	May 20	0.002
Great Bend, Nev.	Apr. 5	May 8	0.01
Horseshoe, Ida.	Apr. 22	May 13	0.03
Indian Queen, Utah.	Apr. 13	May 5	0.005
King David, Utah.	Apr. 13	May 5	0.005
Laclede, Ida.	Apr. 25	May 15	0.003
Lehi Tintic, Utah.	May 10	May 27	0.002
Nassua, Utah.	Apr. 24	May 15	0.005
Nevada-Douglas.	Apr. 17	May 16	0.10
Nine Mile, Idaho.	May 12	June 1	0.0015
North Bunker Hill, Ida.	Apr. 18	May 20	0.002
Old Veteran, Ida.	May 6	June 3	0.02
Overman, Nev.	May 3	May 23	0.05
Pioche Coalition, Nev.	Apr. 17	May 15	0.0025
Plutus, Utah.	Apr. 13	May 5	0.005
Republic, Utah.	Apr. 22	May 13	0.005
Rhode Island, Ida.	Mar. 30	May 15	0.002
Sierra Nevada, Nev.	May 5	May 25	0.05
Snowstorm Ext., Idaho.	May 9	June 13	0.003
Spider, Utah.	Apr. 26	May 15	0.005
Tarbox, Ida.	May 6	June 6	0.05
Tiberius, Ida.	Apr. 15	May 15	0.001
Umatilla, Nev.	Apr. 17	May 22	0.005
Utah-Arizona, Ariz.	Apr. 14	May 16	0.0025
Utah Con., Utah.	Apr. 22	May 13	0 005
Zuma, Utah.	Apr. 24	May 15	0.0025

The following securities were sold at auction recently: $6,000 Ohio Copper Co. first mortage 6% gold bonds, due 1917, Sept., 1914, and subsequent coupons attached. $24,000 Bingham Central Railway Co. first mortage 6% gold bonds, due 1948, Oct. 1914, and subsequent coupons attached, $100 each, $5,200. 175 shares Metropolitan Petroleum Co., Oklahoma corporation, $100 each, $10 lot.

Stock Quotations

SAN FRANCISCO Apr. 25 Name of Comp.	Bid.
Alta	.05
Andes	.07
Best & Belcher	.04
Bullion	.01
Caledonia	.37
Challenge Con.	.05
Confidence	.15
Cons. Imperial	.01
Con. Virginia	.11
Gould & Curry	.02
Hale & Norcross	.03
Jacket-Cr. Pt.	.12
Mexican	.19
Occidental	.70
Ophir	.19
Overman	.03
Savage	.04
Seg Belcher	.03
Sierra Nevada	.20
Union Con.	.53
Utah Con.	.01
Belmont	4.60
Jim Butler	.92
MacNamara	.12
Midway	.29
Mont.-Tonopah	.32
North Star	.19
Rescue Eula	.48
West End Con.	.79
Atlanta	.13
Blue Bell	.02
Booth	.16
C.O.D. Con	.04
Comb. Frac	.09
D'field Daisy	.03
Jumbo Extension	.76
Pitts.-Silver Peak	.07
Round Mountain	.70
Sandstorm Kendall	.04
Silver Pick	.10
Central Eureka	.10
Argo	.50
Big Jim	1.43½
Lazy Boy	.26
Oatman Cres.	.42
Oatman No. Star	.22
Tom Reed	1.70
United Eastern	3.75
United Western	.27

LONDON Apr. 12	
Alaska Tre'dwell	£6 12s 0d
Burma Corp.	1 17 3
Cam & Motor	0 10 9
Camp Bird	0 7 6
El Oro	0 8 3
Esperanza	0 9 6
Mexico Mines	3 15 0
Nechi, pfd.	0 14 3
Oroville	0 14 6
Santa Gert'dis.	0 10 6
Tomboy	1 2 0
Tough Oakes	0 11 3

SALT LAKE Apr. 25 Name of Comp.	Bid.
Beck Tunnel	.24
Black Jack	.11
Colorado Mining	.22
Crown Point	.07
Daly-Judge	7.60
Emma Cop.	.40
Gold Chain	.24
Grand Central	.70
Iron Blossom	1.90
Lower Mammoth	.06
May Day	.17
Opohongo	.02½
Prince Con.	1.25
Seven Troughs	.02½
Silver King Coal'n	2.75
Silver King Con.	2.77½
Sioux Con.	.17
Uncle Sam	.06
Yankee	.41

COLO. SPRINGS Apr. 25	
Acacia	.03¾
Cripple Cr'k Con.	.0075
Doctor Jack Pot	.10
Elkton Con.	.27½
El Paso	.80
Findlay	.04½
Gold Dollar	‡.01
Gold Sovereign	.03½
Golden Cycle	2.23½
Isabella	.19½
Jack Pot	.06
Jerry Johnson	‡.05
Mary McKinney	.33
Portland	1.70
Vindicator	2.58

TORONTO Apr. 25	
Bailey	.07
Chambers Ferland	.25
Coniagas	4.25
La Rose	.56½
Peterson Lake	.27
Right of Way	.04
Seneca Superior	.42
T. & Hudson Bay	26.00
Temiskaming	.64
Trethewey	.15
Wettlaufer-Lor	.08
Dome Exten.	.37
Dome Lake	.24
Foley O'Brien	.43
Hollinger	28.50
Imperial	.03
Jupiter	.20
McIntyre	.91
Porcu. Crown	.62½
Preston E. D.	.04
Vipond	.54
West Dome	.22

N. Y. EXCH. Apr. 25 Name of Comp.	Clg.
Alaska Gold M.	19½
Alaska Juneau	8⅞
Am.Sm.&Ref.,com	93⅝
Am. Sm. & Ref., pf.	112
Am. Sm. Sec., pf. A	93
Am. Sm. Sec., pf. B.	85
Am. Zinc	91
Anaconda	82½
Batopilas Min.	2½
Bethlehem Steel	439
Bethlehem Steel, pf.	133
Butte & Superior	93
Chile Cop.	21
Chino	53
Colo. Fuel & Iron	41⅞
Crucible Steel	81⅛
Dome Mines	24½
Federal M. & S.	15½
Federal M. & S., pf.	36½
Great Nor., ore., ctf.	40
Greene Cananea	46½
Homestake	123½
Inspiration Con.	44⅛
International Nickel	47⅞
Kennecott	55½
Lackawanna Steel	69⅛
Miami Copper	37⅛
Nat'l Lead, com.	65
National Lead, pf.	113
Nev. Consol.	17⅞
Ontario Min.	8¼
Quicksilver	2⅛
Quicksilver, pf.	3½
Ray Con.	22⅛
Republic I&S, com.	46½
Republic I&S, pf.	107⅞
Sloss-Sheffield	50
Sloss-Sheffield, pf.	92
Tennessee Copper	47½
Utah Copper	80½
U. S. Steel, com.	83⅜
U. S. Steel, pf.	116½
Va. Iron C. & C.	46

N. Y. CURB Apr. 25	
Alta Con.	‡.30½
Beaver Con.	.39
Buffalo Mines	1
Butte & N. Y.	2⅛
Butte C. & Z.	7⅛
Can. Cop. Corpn.	1 1/16
Cashboy	.08½
Cerro de Pasco	37½
Con. Ariz. Sm.	1 3/16
Con. Coppermines	1⅛
Con. Nev.-Utah	.50
Dia. Black B.	.04
First Nat. Cop.	5½
Florence	.40
Goldfield Con.	.88
Goldfield Merger	.12½
Granite	.74
Hecla Min.	4⅛
Howe Sound	5½
Kenefick Zinc	14½
Kerr Lake	4½
Magma	17½
Majestic	⅛
McKinley-Dar-Sa.	.57
Mines of Am.	2⅛
Mother Lode	.33
Nevada Hills	.20
New Utah Bingham	2¼
Nipissing Mines	7½
Oro	.05
Ray Hercules	4⅛
Rochester Mines	.63
St. Joseph Lead	15⅛
Stand'd Oil of N.J.	508
Standard S. L.	1⅝
Stewart	9/32
Success	.74
Tonopah	6 5/8
Tonopah Ex.	6 1/16
Tonopah Merger	‡.55
Tribullion	⅛
White Knob, pf.	1¼
Yukon Gold	2

BOSTON EXCH Apr. 25 Name of Comp.	Bid
Adventure	4
Ahmeek	400
Algomah	1¼
Allouez	67
Ariz. Com., ctfs.	8½
Bonanza	.37
Butte-Balaklava	2⅛
Calumet & Ariz.	71⅛
Calumet & Hecla	550
Centennial	16
Copper Range	62½
Daly West	2⅛
East Butte	12⅛
Franklin	8⅛
Granby	84
Hancock	14½
Hedley	20
Helvetia	.35
Indiana	4
Island Cr'k, com.	49½
Island Cr'k, pfd.	89⅛
Isle Royale	28½
Keweenaw	6½
Lake	16½
La Salle	4½
Mason Valley	2½
Mass	12½
Mayflower	3½
Michigan	3½
Mohawk	97
New Arcadian	7½
New Idria	14
North Butte	27
North Lake	1½
Ojibway	2
Old Colony	3
Old Dominion	68½
Osceola	92½
Quincy	94
St. Mary's M. L.	70
Santa Fe	2⅜
Shannon	8⅛
Shattuck-Ariz.	32
So. Lake	7½
So. Utah	.35
Superior	17½
Superior & Bost.	3⅛
Tamarack	54½
Trinity	7½
Tuolumne	.25
U. S. Smelting	70½
U. S. Smelt'g, pf.	51½
Utah Apex	4⅛
Utah Con.	13½
Utah Metal	9½
Victoria	3½
Winona	4
Wolverine	56½
Wyandot	2

BOSTON CURB Apr. 25	
Bingham Mines	12
Boston Ely	.51
Boston & Mont.	.75
Butte & Lon'n Dev.	.82
Calaveras	4½
Calumet-Corbin	.05
Chief Con.	2
Cortez	.60
Crown Reserve	.48
Davis-Daly	1½
Eagle & Blue Bell	1½
Houghton Copper	2½
Iron Cap Cop., pf.	6½
Mexican Metals	.39
Mojave Tungsten	4½
Nat. Zinc & Lead	3½
Nevada-Douglas	.90
New Baltic	2½
New Cornelia	15½
Ohio Copper	.18
Oneco	1½
Raven Copper	.18
Rex Cons.	.17
Rilla	1½
United Verde Ext.	26½

‡Last Quotations.

Monthly Average Prices of Metals

SILVER

Month	New York 1914	New York 1915	New York 1916	London 1914	London 1915	London 1916
January	56.572	48.855	56.775	26.553	22.731	26.960
February	57.506	48.477	56.755	26.573	22.753	26.975
March	58.067	50.241	57.935	26.788	23.708	27.597
April	58.519	50.250	.....	26.958	23.709	.....
May	58.175	49.915	.....	26.704	23.570	.....
June	56.471	49.034	.....	25.948	23.267	.....
July	54.678	47.519	.....	25.219	22.597	.....
August	54.344	47.163	.....	25.979	22.780	.....
September	53.290	48.680	.....	24.260	23.591	.....
October	50.654	49.385	.....	23.199	23.925	.....
November	49.082	51.714	.....	22.703	25.094	.....
December	49.375	54.971	.....	22.900	26.373	.....
Year	54.811	49.684	.....	25.314	23.675	.....

New York quotations cents per ounce troy, fine silver; London, pence per ounce, sterling silver, 0.925 fine.

COPPER

Month	New York Electrolytic 1915	New York Electrolytic 1916	London Standard 1915	London Standard 1916	London Electrolytic 1915	London Electrolytic 1916
Jan.	13.641	24.008	60.756	88.083	65.719	116.17
Feb.	14.394	26.440	63.494	102.667	*	133.167
Mar.	14.787	26.310	66.152	107.714	*	136.000
April	16.811	.....	75.096	.....	*	.....
May	18.506	.....	77.600	.....	*	.....
June	19.477	.....	82.574	.....	95.333	.....
July	18.796	.....	76.011	.....	91.400	.....
Aug.	16.941	.....	68.673	.....	82.333	.....
Sept.	17.502	.....	68.915	.....	85.250	.....
Oct.	17.686	.....	72.601	.....	88.000	.....
Nov.	18.627	.....	77.744	.....	93.273	.....
Dec.	20.133	.....	80.773	.....	100.43	.....
Year	17.275	.....	72.532	.....	.....	.....

TIN

Month	New York 1915	New York 1916	London 1915	London 1916
January	34.260	41.825	156.550	175.548
February	37.415	42.717	176.925	181.107
March	48.426	50.741	180.141	193.609
April	47.884	.....	166.225	.....
May	38.790	.....	162.675	.....
June	40.288	.....	167.636	.....
July	37.423	.....	167.080	.....
August	34.389	.....	151.440	.....
September	33.125	.....	152.625	.....
October	33.080	.....	151.554	.....
November	39.224	.....	167.670	.....
December	38.779	.....	167.000	.....
Av. year	38.590	.....	163.960	.....

LEAD

Month	New York 1915	New York 1916	St. Louis 1915	St. Louis 1916	London 1915	London 1916
January	3.729	5.921	3.548	5.826	18.606	31.167
February	3.827	6.246	3.718	6.164	19.122	31.988
March	4.053	7.136	3.997	7.375	21.883	34.440
April	4.221	.....	4.142	.....	21.094	.....
May	4.274	.....	4.182	.....	20.347	.....
June	5.932	.....	5.836	.....	25.170	.....
July	5.659	.....	5.531	.....	24.611	.....
August	4.656	.....	4.520	.....	21.946	.....
September	4.610	.....	4.490	.....	23.151	.....
October	4.600	.....	4.499	.....	23.994	.....
November	5.155	.....	5.078	.....	26.278	.....
December	5.355	.....	5.266	.....	28.807	.....
Year	4.673	.....	4.587	.....	22.917	.....

SPELTER

Month	New York 1915	New York 1916	St. Louis 1915	St. Louis 1916	London 1915	London 1916
Jan.	6.386	16.915	6.211	16.745	30.844	89.810
Feb.	8.436	18.420	8.255	18.260	39.819	97.762
Mar.	8.541	16.846	8.360	16.676	44.141	95.048
April	10.012	.....	9.837	.....	49.888	.....
May	14.781	.....	14.610	.....	68.100	.....
June	21.208	.....	21.038	.....	100.614	.....
July	19.026	.....	18.856	.....	97.250	.....
Aug.	12.781	.....	12.611	.....	67.786	.....
Sept.	13.440	.....	13.270	.....	67.841	.....
Oct.	12.800	.....	12.596	.....	66.536	.....
Nov.	15.962	.....	15.792	.....	88.409	.....
Dec.	15.391	.....	15.221	.....	89.400	.....
Year	13.230	.....	13.054	.....	67.553	.....

New York and St. Louis quotations, cents per pound, London, pounds sterling per long ton. * Not reported.

PIG IRON IN PITTSBURGH

Month	Bessemer‡ 1915	Bessemer‡ 1916	Basic‡ 1915	Basic‡ 1916	No. 2 Foundry 1915	No. 2 Foundry 1916
January	$14.59	$21.60	$13.45	$18.78	$13.90	$19.70
February	14.55	21.16	13.45	18.93	13.90	19.51
March	14.55	21.81	13.45	19.20	13.95	19.45
April	14.55	.....	13.45	.....	13.95	.....
May	14.61	.....	13.60	.....	13.83	.....
June	14.70	.....	13.67	.....	13.77	.....
July	14.94	.....	13.91	.....	13.68	.....
August	16.01	.....	15.31	.....	14.75	.....
September	16.86	.....	15.95	.....	15.70	.....
October	16.95	.....	15.96	.....	15.80	.....
November	17 57	.....	16.47	.....	17.20	.....
December	19.97	.....	18.44	.....	18.95	.....
Year	$15.82	.....	$14.76	.....	$14.95	.....

‡As reported by W. P. Snyder & Co.